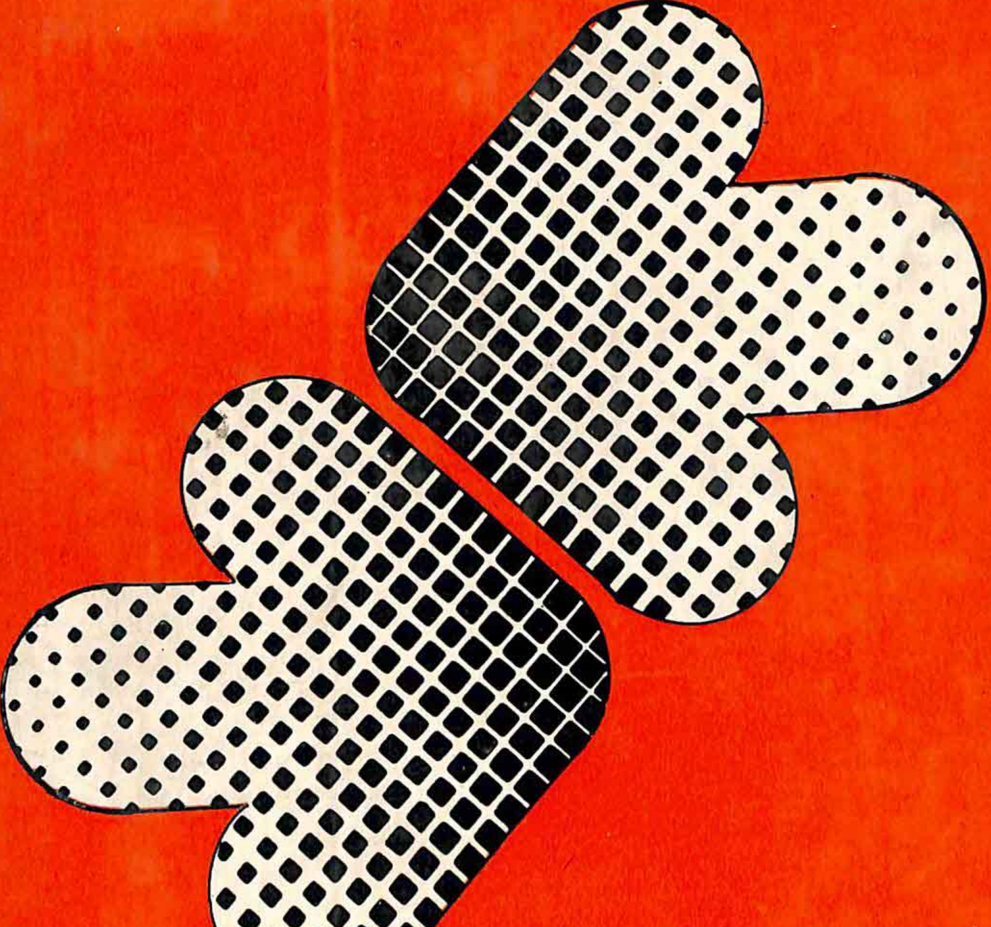
PHYSICS

OBJECTIVE TYPE QUESTIONS WITH ANSWERS

For Civil Services and other Competitive Examinations



S. Hari Haran M.K.Goel

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&
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PHYSICS: Objective Type Questions & Answers

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PREFACE

With the introduction by the Union Public Service Commission of the new pattern of examination for recruitment to the Central Civil Services, it has become compulsory for candidates taking this examination to appear in an objective type test. This type of test is also adopted in many other examinations conducted by other Service Commissions and other Recruitment boards. For success in these tests, ability to answer questions with quickness and accuracy counts more, which can be secured by some practice of these type of questions.

The authors have long felt the absence of a good objective type book for these examinations. In this book, a sincere effort has been made to frame standard questions covering each and every part of the syllabus. The questions have been designed to test the indepth knowledge of the candidate while at the same time clearing minute misconceptions in the fundamentals of the subject. The authors trust that this book will be found very useful and handy by all the candidates taking the examination.

Suggestions for improving the usefulness of this book are most welcome and would be gratefully acknowledged.

Authors

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Mechanics

1. Two forces A and B acting at right angles to each other will have resultant of magnitude

   (a) $\frac{A^2+B^2}{2}$ (b) $\sqrt{A^2+B^2}$

   (c) $\sqrt{\frac{A^2+B^2}{2}}$ (d) zero

2. Which of the following is the only scalar quantity

   (a) Energy (b) Velocity

   (c) Momentum (d) Acceleration

3. Rain drops fall from a great height under gravity. Tick the only correct statement with respect to their velocity

   (a) They fall with terminal velocity in direct proportion to their size
   (b) Their velocity goes on increasing till they hit the ground
   (c) They fall with a terminal velocity which is same for every drop
   (d) None of the above

4. If the earth is a homogeneous sphere, and an observer A is moving down a mine and another observer B is moving up from the surface in a rocket, then the acceleration due to gravity as measured by

   (a) A goes on increasing, while that by B decreases
   (b) A goes on decreasing, while that by B increases
   (c) A and B remains constant
   (d) A and B goes on decreasing

5. An astronaut floats in space with a life line attached to the spaceship what will happen if the life line is cut by accident

   (a) he will go to the outer space
   (b) he will fall to the earth below

(c) he will continue to orbit
(d) cannot be said

6. Gravitational potentional has the dimensions

(a) $M^0 L^0 T^{-2}$ (b) $M^0 L^2 T^{-2}$
(c) $M^0 L^1 T^{-1}$ (d) $M^0 L^0 T^{-2}$

7. Dimensions of Radius of gyration is

(a) $M^0 L^{-1} T^0$ (b) $M^0 L^1 T^0$
(c) $M^0 L^0 T^{-1}$ (d) $M^0 L^0 T^{+1}$

8. Dimension formula for moment of inertia is

(a) $M^0 L^2 T^0$ (b) $M^0 L^3 T^1$
(c) $M^0 L^1 T^0$ (d) $M^0 L^0 T^1$

9. Dimension formula for the Coefficient of elasticity is

(a) $M^0 L^1 T^{-1}$ (b) $M^{-2} L^{-1} T^{-2}$
(c) $M^{-1} L^{-1} T^{-3}$ (d) $M L^{-1} T^{-2}$

10. Dimension formula for the surface tension is

(a) $ML^0 T^{-2}$ (b) $M^0 L^0 T^{-1}$
(c) $M^0 L^1 T^{-1}$ (d) $M^0 L^0 T^{-3}$

11. Dimensional analysis can be used for

(a) conversion of one system of units into another
(b) checking the results obtained
(c) deriving the correct relationship between different physical quantities
(d) all of the above

12. The dimensional formula of work is not equal to the dimensional formula of

(a) potential energy (b) kinetic energy
(c) couple (d) power

13. Dimensional formula for pressure is the same as that for

(a) density (b) stress
(c) strain (d) specific gravity

14. Which of the following is not a fundamental unit

(a) ampere (b) kelvin
(c) length (d) area

15. Which of the following is a fundamental unit

(a) candela (b) area
(c) acceleration (d) velocity

16. SI units of momentum are

(a) newton-metre (b) newton-second
(c) newton-metre^2 (d) newton-metre^{-1}

17. SI unit of current is

(a) mA (b) A
(c) μA (d) none of the above

18. SI unit of power is

(a) watt (b) joule
(c) joule metre^{-3} (d) newton-metre

19. SI unit of energy density is

(a) joule—metre^{2} (b) joule –metre^{-3}
(c) joule—metre^{-2} (d) joule—metre

20. SI unit of time is the same as that of

(a) frequency (b) period
(c) both of the above (d) none of the above

21. Gravitational attraction increases with increasing

(a) permiability (b) directivity
(c) selectivity (d) temperature

22. Gravitational potential is

(a) a negative quantity with zero at infinity
(b) a positive quantity with zero at infinity
(c) a positive quantity with zero at origin
(d) none of the above

23. For a body to escape the gravitational field of earth, its velocity should be

(a) equal to $\sqrt{2MG/R}$ (b) less than $\sqrt{2MG/R}$
(c) more than $\sqrt{2MG/R^2}$
(d) more than $\sqrt{2MG/R}$

24. Moon's atmosphere is deficient in oxygen, nitrogen, carbon-dioxide, water vapour, helium and hydrogen because

(a) at the time of formation of moon these elements were missing
(b) these gases have disappeared because of chemical recombination
(c) these gases have escaped the atmosphere of moon
(d) cannot be said

25. Gravitational potential inside a spherical shell is

(a) equal to that of a point outside the shell
(b) equal to that of any other point inside the shell
(c) equal to unity (d) infinity

26. The ratio of orbital velocity and escape velocity is

(a) $1/\sqrt{2}$ (b) $\sqrt{2}$
(c) 2 (d) $\sqrt{2.1}$

27. Orbital velocity is given by the formula
    - (a) $\sqrt{gR}$ (b) $\sqrt{2gR}$
    - (c) $\sqrt{g/R}$ (d) $\sqrt{g/2R}$

28. What shall be the weight of a scientific apparatus weighing 15 kg on earth when placed in a satellite travelling at a speed of 3000 m/sec around the earth at a height of 500 metres
    - (a) 12 kg (b) 23 kg
    - (c) 0 kg (d) 15 kg

29. Height of a geostationary satellite above the earth is
    - (a) 30,000 km (b) 25,000 km
    - (c) 36,000 km (d) 40,000 km

30. Minimum number of communication satellites required to cover the whole earth is
    - (a) 4 (b) 3
    - (c) 2 (d) 5

31. Velocity of a satellite in elliptical orbit is maximum at
    - (a) its perigee (b) its apogee
    - (c) it is same throughout
    - (d) none of the above

32. The velocity of satellite moving around the earth at a height h is given by
    - (a) $\sqrt{GM/(R+h)}$ (b) $\sqrt{(R+h)/GM}$
    - (c) $\sqrt{2GM/(R+h)^3}$ (d) $\sqrt{2GM/h}$

33. Inertial mass is
    - (a) equal to gravitational mass
    - (b) more than gravitational mass
    - (c) less than gravitational mass
    - (d) cannot be related to gravitational mass

34. The escape velocity of a projectile when launched from the surface of any planet
    - (a) depends upon the mass of the projectile
    - (b) depends upon the mass and radius of the planet
    - (c) depends upon the launching direction
    - (d) depends upon the size of the projectile

35. Acceleration due to gravity on the surface of the moon is one-sixth of the acceleration due to gravity on the earth and diameter of the moon is one-fourth that of the earth. If the escape velocity for the earth is 7 miles/sec, then the escape velocity for the moon is

(a) 7/24 miles/sec (b) 7×24 miles/sec
(c) $7/\sqrt{24}$ miles/sec (d) $7 \times \sqrt{24}$ miles/sec

36. A body is thrown vertically upwards with a velocity of 9.8 m/sec. What shall be the height attained by it

(a) 9.8 m (b) 19.6 m
(c) 29.4 m (d) 4.9 m

37. An orbiting satellite receives centripetal force from

(a) the rocket engine attached to the satellite
(b) the gravitational pull of the sun on the satellite
(c) the gravitation attraction of the earth on the satellite
(d) none of the above

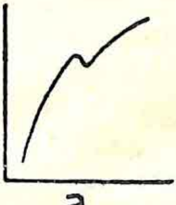
38. For maximum linear distance of travel, a projectile motion must be fired at an angle of

(a) 0° (b) 45°
(c) 60° (d) 90°

39. Cream separation from milk after churning is an example of

(a) cohesive force (b) adhesive force
(c) gravitational force (d) centrifugal force

40. The general stress-strain diagram for a bar is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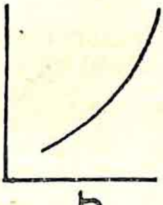
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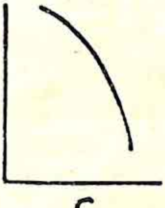
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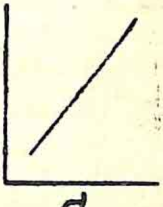
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41. The maximum load to which a bar can be subjected, divided by its original cross-sectional area is called

(a) yielding stress (b) breaking stress
(c) residual stress

42. Which statement is wrong with respect to elastic hysteresis

(a) the lag between stress and strain is called elastic hysteresis
(b) elastic hysteresis is similar to the phenomenon of magnetic hysteresis
(c) the energy dissipated as heat during loading and unloading cycle is given by the area enclosed by the loop
(d) some metals do not show elastic hysteresis

43. Factor of safety in elasticity is defined as
    (a) Yielding stress/ Breaking stress
    (b) Breaking stress/Working stress
    (c) Working stress/ Yielding stress
    (d) none of the above

44. Elastic property can be increased by a process of
    (a) hammering and rolling
    (b) annealing
    (c) increasing temperature
    (d) anodising

45. Young's Modulus is defined by
    (a) (F/a)/(l/L) (b) (F/a)/(v/V)
    (c) (F/a)/θ (d) none of the above

46. Bulk's Modulus of elasticity is given by
    (*a*) (F/a)/(l/L) (b) (F/a)/(v/V)
    (c) (F/a)/θ (d) none of the above

47. Modulus of Rigidity is defined by
    (a) (F/a)/(l/L) (b) (F/a)/θ
    (c) (F/a)/(v/V) (d) none of the above

48. Bulk Modulus is same as
    (a) compressibility (b) incompressibility
    (c) shear stress (d) breaking stress.

49. Addition of impurities to metal
    (a) will enhance the elasticity
    (b) will decrease the elasticity
    (c) will not affect the elasticity
    (d) may or may not affect elasticity

50. Relation connecting the elastic constants is
    (a) $\frac{9}{n}=\frac{3}{y}+\frac{1}{k}$ (b) $\frac{9}{y}=\frac{3}{n}+\frac{1}{k}$
    (c) $\frac{9}{k}=\frac{3}{y}+\frac{1}{n}$ (d) $\frac{9}{k}=\frac{3}{n}+\frac{1}{y}$

51. Resilience of an elastic body is defined by
    (a) $(\text{Stress})^2/2\times$ Young's Modulus
    (b) Stress/2 × Young's Modulus
    (c) Strain/Young's Modulus
    (d) Stress/Strain

52. Point out the false statement with respect to elasticity
    (a) A continuously vibrating wire gets tired or fatigued.

(b) The elastic properties of a material are linked to its mass structure.
(c) The effect of a suddenly applied load is to produce a stress double than that produced by a gradually applied one.
(d) All the above statements are false.

53. Bending moment of a beam with R as the radius of curvature and I_g as the moment of inertia is given by

(a) $\frac{Y}{2R} \cdot I_g$ (b) $\frac{Y}{R} \cdot I_g$

(c) $\frac{2Y}{R} \cdot I_g$ (d) $\frac{2Y}{R} \cdot I^2_g$

54. If a tube with a diaphragm closing the lower end and filled with water is dipped in a larger body of water, what can be said of pressure at the diaphragm in the conditions

(i) when the tube is vertical (ii) when the tube is tilted by an angle of 45°

(a) Pressure in both cases will be the same.
(b) Pressure in vertical case will be more.
(c) Pressure in tilted case will be more.
(d) None of the above

55. Centroid or Centre of mass is

(a) same as centre of gravity in all cases
(b) different in different cases.
(c) equal to centre of gravity for uniform in non-uniform gravitational field cases only.
(d) equal to centre of gravity in non-uniform gravitational field cases only.

56. Which of the following is a case of stable equilibrium

(a) A tilted rectangular body with meta centre M above the C.G in tilted position.
(b) A tilted rectangular body with meta centre M below the C. G. in tilted position.
(c) The case of a spherical body.

57. A boat is stationary in water initially. What happens if a gunman starts firing in a horizontal direction.

(a) The boat will capsize.
(b) The boat will spin around.
(c) The boat will move in the direction of the target.
(d) The boat will move away from the target.

58. In a curved streamline

(a) pressure on both sides of it is equal.

(b) Pressure on the convex side is greater than on the concave side.
(c) Pressure on the concave side is greater than on the convex side.

59. Which is a correct statement for a flowing fluid.

(a) Its kinetic energy and potential energy are mutually convertible but not the pressure energy.
(b) Its kinetic and pressure energies are mutually convertible but not the potential energy.
(c) Its potential and pressure energies are mutually convertible but not the kinetic energy.
(d) All the three energies are mutually convertible.

60. Which one is not a correct statement of Bernoulli's theorem (v=velocity of fluid, p=pressure of fluid, p=density of fluid)

(a) gravitational head+pressure head+velocity head=a constant
(b) $p/\rho g+\frac{1}{2}\rho v^2=$ a constant
(c) $p+\frac{1}{2}\rho v^2$ = a constant
(d) $v+\frac{1}{2}\rho v^2$ = a constant

61. Velocity of efflux of a liquid through an orifice is equa to

(a) $\sqrt{2gh}$ (b) $\sqrt{gh}$
(c) $\sqrt{2/gh}$ (d) 2gh

62. Vena contracta is

(a) another name for venturimeter
(b) the diameter of an orifice
(c) the diameter of a jet issuing out of an orifice.
(d) the neck diameter of a jet issuing from an orifice.

63. Which of the following is not an application of Bernoulli's principle

(a) The Atomizer (b) The Bunsen Burner
(c) The Kerosene lamp (d) The steam injector.

64. A fisherman is carrying 5 kg of fish on his back and a bucket in the other hand containing 5 kg of water. His son is carrying the two things of same weight with the difference of carrying fishes in the bucket. Who is carrying lesser weight.

(a) Both are carrying equal weight.
(b) The fisherman.
(c) His son.

65. In a balanced physical balance what will happen if air is blown horizontally by a tube under one of the pans.

(a) they will remain unaffected
(b) the pan will go down
(c) the pan will go up

66. Poise is a unit of

(a) Gravitational field on poles
(b) Suction pressure
(c) Coeff of viscosity
(d) Coeff of elasticity

67. Coeff. of viscosity is given by the relation (η=coeff of viscosity F=force, A=Area, dv/dx=velocity gradient)

(a) $F=\eta A d\theta/dx$ (b) $\eta=-F/(A dv/dx)$
(c) $F=\frac{A}{\eta}\cdot\frac{d\theta}{dx}$ (d) $F=\frac{A\eta}{dv/dx}$

68. Critical velocity of a fluid is given by (where k= Reynold's number)

(a) $V_c=K\eta/\rho r$ (b) $V_c=K\rho/\eta r$
(c) $V_c=Kr/\rho\eta$ (d) $V_c=\rho\eta/Kr$

69. Reynold number in the case of two geometrically similar aeroplanes of different sizes

(a) is more in the case of the bigger aeroplane
(b) is less for the smaller aeroplane
(c) is same in both the cases
(d) is more for the smaller aeroplane

70. In the venturimeter the flow of liquid can be measured by the formula

(a) $V_1=a_2\sqrt{\frac{2(p_1-p_2)}{a_1^2-a_2^2}}$

(b) $V_1^2=a_2\sqrt{\frac{2(p_1-p_2)}{a_1^2-a_2^2}}$

(c) $V_1=a_2^2\sqrt{\frac{2(p_1-p_2)}{a_1^2-a_2^2}}$

(d) $V_1=a_1a_2\sqrt{\frac{2(p_1-p_2)}{a_1^2-a_2^2}}$

71. A corked bottle contains water with a tube dipped into it and having a jet at the upper exposed end. If air is blown through another jet at the upper end near the jet of the dipped tube,

(a) the air will go through the tube into the bottle and bubble through

(b) the water will come out in a spray
(c) nothing will happen
(d) water will be sucked by the blowing jet

72. Poiseuille's formula for flow of liquid through a tube is given by

(a) $\eta = \frac{\pi P r^4}{8vl}$ (b) $\eta = \frac{\pi P r^3}{6vl}$
(c) $\eta = \frac{\pi P^2 r^4}{8vl}$ (d) $\eta = \frac{\pi P^2 r^3}{8vl}$

73. Poiseuille's formula holds good when

(a) the flow is steady and streamlined
(b) the pressure is constant over every cross-section
(c) the liquid in contact with the sides of the tube is stationary
(d) all of the above

74. Strokes formula for the terminal velocity of a body through a viscous medium is given by

(a) $V = 3/9 r^3 g(\rho - \sigma)/\eta$ (b) $V = 2/8 r^3 g^2(\sigma - \rho)/\eta$
(c) $V = 2/9 r^2 g(\sigma - \rho)/\eta$ (d) $V = 2/9 r^2 g(\rho - \sigma)/\eta$

75. A bomber is flying horizontally with a constant speed of 150 metres/sec at a height of 78.4 metres. The pilot has to drop a bomb at the enemy target. At what horizontal distance from the target should he release the bomb so as to score a perfect hit

(a) 1000 metres (b) 300 metres
(c) 600 metres (d) 100 metres

76- A rubber ball falling from a height of 5 metres rebounds from a hard floor and loses 30% of the energy in impact. What is the height of rebound

(a) 4 metres (b) 3.5 metres
(c) 3 metres (d) 5 metres

77. A ball and a Mud lump of same mass and velocity are thrown out at a wall. What will be the impulses exerted by them

(a) the rubber ball will impart greater impulse
(b) the mud lump will impart greater impulse
(c) both will impart the same impulse
(d) none of the above

78. A person is stranded on a frictionless glass surface. How can he move out of it?

(a) by spitting or sneezing
(b) by jumping vigourously

(c) just walk off
(d) can't leave the surface

79. A tensile force of 2×10^5 dynes doubles the length of a flexible tube of 2 sq cm cross sectional area, the Young's Modulus of the flexible material is

(a) 8×10^5 dynes/sq cm (b) 1×10^5 dynes/sq cm
(c) zero (d) 2×10^5 dynes/sq cm

80. A man weighs 100 kg on a platform balance in stationary lift. What will be the weight if the lift starts moving up with an acceleration of 4.9 m/sec

(a) 100 kg (b) 120 kg
(c) 150 kg (d) 200 kg

81. Value of g at the moon surface is 1/6 of g at the surface of the earth and the diameter is only 1/4 of that of the earth. The ratio of escape velocity at the moon and the earth is thus

(a) 1:4 (b) 1:3
(c) 1:4.9 (d) 1:24

82. What is the potential energy lost by a man weighing 50 kg, if he jumps to death from a 10 metre high building

(a) $50\times10\times9.8$ joule (b) 50×10 joule
(c) $50^2\times10\times9.8$ joule (d) 10×9.8 joule

83. Kinetic energy of a particle of mass 5 kg moving with a velocity of 2m/sec is

(a) 15 joule (b) 20 joule
(c) 10 joule (d) 5 ergs

84. What is the outward force acting on a mass of 10 kg. tied to an inelastic string of 1m. length and rotated at a speed of 1m/sec

(a) 1N (b) 1.5N
(c) 2N (d) 2.5N

85. The length of a seconds pendulum is 50m. at earth. What will be its length at a planet with a 'g' of 4.9 m/sec^2 only

(a) 50m (b) 100m
(c) 25m (d) none of the above

86. A chimpanzee is swinging on a swing in a sitting position. Suddenly he stands up. What will a physicist infer from this about the period of the swing

(a) the period will increase
(b) the period will decrease
(c) period won't change
(d) none of the above

87. An experiment is conducted in a uniformly accelerated lift in which the period of a pendulum is observed. The observation in comparison to the stationary state is that

(a) the period becomes shorter as the lift moves up
(b) the period becomes longer as the lift moves up
(c) the period remains same
(d) none of the above

88. Molecular Range is of the order of

(a) 10^{-8} cm (b) 10^{-7} cm
(c) 10^{-9} cm (d) 10^{-6} cm

89. The moment a paint brush is immersed in water, it spreads out its hair and the moment it is taken out it contracts itself. This is an example of

(a) viscosity (b) elasticity
(c) surface tension (d) none of the above

90. If a wire ring is taken and dipped into soap solution, a film of soap solution is formed across it. Suppose now a moistened thread in the shape of a loop is placed gently on the film and the film inside the threadloop is pricked, What will happen to thread

(a) the thread will fall out
(b) the thread loop will open out into a circle
(c) both of the above
(d) none of the above

91. The force per unit length of a line drawn in a liquid surface, acting perpendicular to it at every point and tending to pull the surface apart along the line is called

(a) viscous force (b) surface tension
(c) van der waals force (d) none of the above

92. When a molecule from the interior of a liquid is brought to its surface from film, work has to be done on it. It means therefore that the

(a) potential energy of molecules in the surface film is lesser than of those inside the liquid
(b) potential energy of molecules in the surface film is more than of those inside the liquid
(c) potential energy both inside and the surface of the liquid is same.
(d) the potential energy of the surface film is zero

93. Excess pressure inside a liquid drop is given by

(a) $2T/\gamma$ (b) $T/2\gamma$
(c) T/γ (d) T^2/γ

94. Find out the correct statement

(a) smaller is the soap bubble, smaller is the pressure inside
(b) smaller is the soap bubble, greater is the pressure
(c) larger is the soap bubble, larger is the pressure inside
(d) none of the above

95. Work done in blowing a bubble is given by

(a) $8\pi\gamma^2T$ (b) $8\pi^2\gamma T$
(c) $8\pi\gamma T^2$ (d) $8\pi\gamma^2T^2$

96. If the meniscus of a liquid in a tube is convex then its

(a) force of adhesion with glass is more than the force of cohesion
(b) force of adhesion is less than the force of cohesion
(c) force of adhesion is equal to the force of cohesion
(d) none of the above

97. Which one of the following does not affect surface tension

(a) contamination of liquid surface
(b) presence of dissolved substance
(c) change of the liquid
(d) viscosity of the liquid

98. The force keeping the planets in a regular orbit is

(a) electrostatic force (b) magnetic force
(c) gravitational force (d) nuclear force

99. A satellite in orbit in air free atmosphere

(a) does not require further energy
(b) derives energy from the sun
(c) moves under the influence of the gravitational force only
(d) is kept in orbit by ground control

100. The minimum velocity of projection to go out from earth's gravitational pull is called

(a) terminal velocity (b) escape velocity
(c) angular velocity (d) orbital velocity

101. The retro-rocket is used

(a) to launch the satellite
(b) to accelerate the satellite
(c) to bring back the satellite
(d) to let the satellite escape into space

102. A rocket moves according to the principle of conservation of

(a) energy (b) mass
(c) momentum (d) force

103. A freely falling iron ball will possess

(a) constant acceleration (b) constant velocity
(c) constant speed (d) variable acceleration

104. A body travelling in circular orbit at constant speed has

(a) constant velocity
(b) an outward radial acceleration
(c) an inward radial acceleration
(d) acceleration in a direction tangent to the circular path

105. A bullet of mass 25 gms is fired with a speed of 250 m/sec from a gun of 2.5 kg weight. The velocity of recoil is

(a) 2.5 m/sec (b) 5 m/sec
(c) 1.5 m/sec (d) 250m/sec

106. In jet propulsion the principle involved is

(a) conservation of energy
(b) conservation of mass
(c) conservation of momentum
(d) none of the above

107. An inkpot is placed on the newspaper sheet. The newspaper can be suddenly pulled out without disturbing the inkpot, because

(a) the inkpot is full
(b) the inkpot is frictionless
(c) of the inertia of the inkpot
(d) the inkpot is not sticking to the newspaper

108. In a simple harmonic motion

(a) P.E. is constant
(b) K.E. is constant
(c) Amplitude is constant
(d) Phase is constant

109. In a pendulum executing simple harmonic motion

(a) total momentum is conserved
(b) total energy is conserved
(c) electrical energy is conserved
(d) mass is conserved

110. Blanking of railway track is done so that

(a) apparent weight of train may be reduced
(b) the train may not topple inward
(c) no friction will be generated
(d) none of the above

111. Hook's law defines a relation between
   - (a) Force and Velocity
   - (b) Stress and Strain
   - (c) Mass and Acceleration
   - (d) Potential energy and Height

112. If a hole is bored through the centre of the earth and a pebble is dropped in it, then it
   - (a) sticks to the side of the earth
   - (b) executes S.H.M.
   - (c) stops at the centre of the earth
   - (d) drops to the other side

113. Gravitational force between two bodies is
   - (a) inversely proportional to the cube of the distance between them
   - (b) directly proportional to the product of the masses of the two bodies
   - (c) inversely proportional to the product of the masses of the two bodies
   - (d) directly proportional to the square of the distance between them

114. When the mass and speed of a body are doubled, its kinetic energy
   - (a) increases 16 times (b) increases 8 times
   - (c) increases 4 times (d) increases 3 times

115. Moment of inertia of a thin uniform rod about an axis through its centre and perpendicular to its length is given by
   - (a) $I=\frac{Ml^2}{12}$ (b) $I=\frac{Ml^3}{12}$
   - (c) $I=\frac{Ml^3}{8}$ (d) $I=\frac{M^2l}{12}$

116. Moment of inertia of a solid uniform bar of rectangular cross-section about an axis, perpendicular its centre and passing through its middle point is given by
   - (a) $I=\frac{M(l^2+d^2)}{8}$ (b) $I=\frac{M(l^2+d^2)}{12}$
   - (c) $I=\frac{M^2(l+d)}{12}$ (d) $I^2=\frac{M(l+d)}{12}$

117. What will be the moment of inertia of an elliptical lamina of 4 and 2 metres major and minor axis and having a mass of 5 kg

(a) 50 kg-m^2 (b) 15 kg-m^2
(c) 25 kg-m^2 (d) 10 kg-m^2

118. Moment of inertia of a solid cylinder about an axis passing through its centre and perpendicular to its axis of cylindrical symmetry is given by

(a) $M\left(\frac{R^2}{4}+\frac{l^2}{3}\right)$ (b) $M\left(\frac{R^2}{8}+\frac{l^2}{3}\right)$
(c) $M\left(\frac{R^2}{4}+\frac{l^2}{12}\right)$ (d) $\frac{3MR^2}{10}$

119. What is the moment of inertia about the vertcıal axis of a solid cone of 5 kg mass and 2 metres radius at the base,

(a) 60 kg-m^2 (b) 10 kg-m^2
(c) 2 kg-m^2 (d) 6 kg-m^2

120. Which of the following is not amongst the statement of Routh's Rule

The moment of inertia of a body about any one of the three perpendicular axes of symmetry passing through its centre of mass is given by

(a) the product of its mass and one-third of the sum of the square of the other two semi-axes, in the case of a rectangular lamina or perpendicular
(b) the product of its mass and one-third of the sum of the squares of the other two semi-axes, in the case of a circular or an elliptical lamina
(c) the product of its mass and one-eighth of the sum of the squares of the other two semi-axes, in the case of a sphere
(d) the product of its mass and one-fifth of the sum of the squares of the other two semi-axes, in the case of a spheroid

121. The magnitude of the resultant of two concurrent forces may be increased by

(a) drawing the triangle to represent them
(b) increasing the angle between them
(c) decreasing the angle between them
(d) drawing a parallelogram to represent them

122. It is easier to swim in sea water than in river water because

(a) sea water is more dense than river water
(b) sea water has waves
(c) sea water pushes the man quickly to the shore
(d) sea is a large body of water

123. Which one of the following is not a factor affecting the acceleration due to gravity

(a) latitude of the place (b) longitude of the place
(c) altitude of the place (d) depth of the place

124. Two bodies of different masses are moving in circular orbits under the influence of each other's gravitational attraction. Therefore

(a) the heavier of the two has greater angular velocity
(b) the lighter of the two has greater angular velocity
(c) their angular velocities are independent of each other
(d) their angular velocities are equal

125. Equation of planetary motion can be expressed as

(a) $GM_s = \frac{4\pi^2r^3}{T^2}$ (b) $GM_s = \frac{4\pi^2r^2}{T^2}$

(c) $GM_s = \frac{4\pi r^3}{T^2}$ (d) $GM_s = \frac{4\pi^2r^2}{T^3}$

126. If M_e is the mass of the earth and M_s that of sun, what is the binding energy of the earth-sun system if V_s is the radius of the earth's orbit (assumed to be circular)

(a) $\frac{-M_sM_e}{2r_s}$ (b) $\frac{-M_sM_e}{2r^2s^2}$

(c) $\frac{-GM_eM_s}{2r_s}$ (d) $\frac{-GM_eM_s}{2r^2_s}$

127. Where can we have more sugar to a kg weight

(a) at the equator
(b) at the poles
(c) it will be same everywhere
(d) none of the above

128. The sun attracts all bodies on the earth. At midnight when the sun is directly below, it pulls on an object in the same direction as the pull of the earth on that object, at noon when the sun is directly above, it pulls on an object in the direction opposite to the pull of the earth. Hence all objects

(a) weigh more at midnight than at noon
(b) weigh less at midnight than at noon
(c) weigh equal at both the times
(d) experience only negligible change in weight

129. The nucleus of a helium atom travels along the inside of a straight hollow tube 2.0 metres long which forms part of a particle accelerator. If one assumes uniform acceleration,

for how long it is in the tube if it enters at a speed of 1000 m/sec and leaves at 9000 m/sec

(a) 4.0×10^{-4} sec	(b) 8×10^{-4} sec
(c) 16×10^{-4} sec	(d) 2×10^{-4} sec

130. A body is dropped from rest and falls freely. Where is the position of the body after 4 seconds

(a) 144 ft	(b) 64 ft
(c) 256 ft	(d) 16 ft

131. A rabbit is 10 metres away from the head of a lettuce. What will be the time taken by it to reach the lettuce if it moves at the speed of 5 m/sec but stops to take breath after each coverage of half the distance between it and the lettuce

(a) 2^5 sec	(b) 2^2 sec
(c) 2^1 sec	(d) it will never reach there

132. Two trains, each having a speed of 30 km/hour are headed at each other on the same track. A crow that can fly 60 km/hour flies off from one of the train when they are 60 km apart and heads directly for the other train. On reaching the other train it flies back to the first train and so forth. How many trips can the crow make from one train to the other before they crash and what is the total distance the bird travel.

(a) 6000 trips and 600 km
(b) 600 trips and 600 km
(c) infinite trips and 6000 km
(d) infinite trips and 60 km

133. A ball is dropped on the floor from a height of 4 ft. It rebounds to a height of 3 ft. If the ball was in contact with the floor for 0.010 sec, what was its average acceleration during contact

(a) 3000 ft/sec^2 downwards
(b) 300 ft/sec^2 downwards
(c) 3000 ft/sec^2 upwards
(d) 300 ft/sec^2 upwards

134. The moon revolves round the earth, making a complete revolution in 27.3 days. Assuming that the orbit is circular with a radius of 239,000 miles, what is the magnitude of acceleration of the moon towards the earth

(a) 2.78×10^{-4} g	(b) 27.8×10^{-4} g
(c) 0.278×10^{-4} g	(d) 278×10^{-4} g

135. To improve his jumping record, a long jumper should

(a) jump as high as possible
(b) jump at an angle of 45°
(c) jump at an angle of 60°
(d) none of the above

136. A boy sitting in a railroad car moving at a constant velocity throws a ball straight up into the air. The ball will drop

(a) behind him (b) in front of him
(c) in his hand (d) beside him

137. Drops are falling vertically in a steady rain. In order to go through the rain from one place to another in such a way as to encounter the least number of rain drops, should you move

(a) with greater speed
(b) with least possible speed
(c) with an intermediate speed
(d) standstill

138. A massless rope is strung over a frictionless pulley. A monkey holds onto one end of the rope and a mirror, having the same weight as the monkey, is attached to the other end of the rope at the monkey's level. Can the monkey get away from his image seen in the mirror

(a) by climbing up the rope
(b) by climbing down the rope
(c) by releasing the rope
(d) he can never get away

139. Which of the following is a pseudo force

(a) gravitational force
(b) centrifugal force
(c) electromagnetic force
(d) nuclear force

140. What happens to the potential energy an elevator loses in coming down from the top of a building to a stop at the ground floor

(a) It is converted into heat
(b) It is converted into Kinetic energy
(c) It is conserved
(d) none of the above

141. The centre of mass of a system of particles depends only

(a) upon the masses of the particles
(b) upon the position of the particles relative to one another

(c) upon the packing density of the particles
(d) on the masses of the particles and the position of the particles relative to one another

142. A dog weighing 15 kg is standing in a boat and is at a distance of 5 metres from the shore. What will happen if it walks towards the shore

(a) its distance from the shore will remain the same
(b) the distance will decrease
(c) the distance will increase
(d) the dog cannot walk on a still boat

143. A particle executing uniform circular motion, in the rotating frame fixed to it, experiences/experience

(a) a centripetal force only
(b) centrifugal force only
(c) both centripetal and centrifugal force
(d) neither centripetal nor centrifugal force

144. A particle uniformly accelerated in a circle has

(a) radial acceleration zero and transverse acceleration non-zero
(b) non-zero radial acceleration and zero transverse acceleration
(c) non-zero radial acceleration and non-zero transverse acceleration
(d) radial acceleration and transverse acceleration

145. Is a ship more stable when empty than when loaded

(a) yes (b) no
(c) cannot be said

146. A bomb is falling freely under the force of gravity and in the course of its motion it bursts. The centre of mass of the scattered fragments in their descent will be

(a) at the point of explosion
(b) at the maximum size fragment
(c) at the same vertical line
(d) difficult to locate

147. A parrot in a wire canary is hanging from a spring balance. First the bird sits in the cage, and then it flies about. Thus

(a) the reading of the balance in the first case is larger
(b) reading of the balance remains constant
(c) reading of the balance in the first case is smaller
(d) the balance would read zero

148. The weight of the body at the centre of the earth

(a) is infinite
(b) is zero
(c) is slightly more than at the surface
(d) is very less compared to the value at the surface

149. A lead ball of 50 kg and an iron ball of 25 kg, both of the same diameter are dropped from the top of a building. When they are 15 metres above the ground, they have identical

(a) acceleration (b) momenta
(c) Kinetic energy (d) potential energy

150. Newton's law of gravitation applies to

(a) solar system only
(b) galaxies in this universe only
(c) milky way galaxy only
(d) all bodies in the universe

151. First of all G was measured in laboratory by

(a) kepler (b) Newton
(c) Airy (d) Cavendish

152. Three coplaner forces acting on a rigid body keep it in equilibrium. They should therefore be

(a) parallel (b) concurrent
(c) non-parallel (d) non-concurrent

153. When two bodies separate instantaneously after collision, the collision is said to be

(a) perfectly elastic (b) perfectly in-elastic
(c) partially elastic

154. Which of the following instrument can be used for measuring pipe-flow

(a) viscometer (b) venturitube
(c) hygrometer (d) filter pump

155. According to special theory of relativity, space and time have

(a) absolute meaning (b) relative meaning
(c) selective meaning

156. If E is the energy of a photon, its mass is equivalent to

(a) E^2/C (b) EC^2
(c) E/C^2 (d) EC^3

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157. An observer from his time frame notices the length of each object on the earth to be reduced by half. Therefore his time interval has

(a) also become half (b) has been doubled
(c) remained unchanged

158. Which of the following was a direct result of Michelson's Moreley's experiment in relation to relativity

(a) sun's spectrum contains black lines
(b) velocity of earth with respect to hypothetical ether was zero
(c) velocity of earth with respect to hypothetical ether was non-zero
(d) none of the above

159. Einstein's relation between mass and energy is given by

(a) $E=pc+m_0c^2$ (b) $E^2=\sqrt{p^2c^2+m_0^2c^2}$
(c) $E^2=p^2c^2+m_0^2c^4$ (d) $E^2=\sqrt{p^2c^2+m_0^2c^4}$

160. Minkowski's space is

(a) a multidimensional space
(b) a bidimensional space
(c) a tridimensional space
(d) a four dimensional space

161. According to Einstein's theory of relativity, if the velocity of a particle goes on increasing, its mass

(a) remains unchanged (b) increases
(c) decreases

162. Tick the incorrect statement

(a) Moving electron have charge independent of their speed
(b) Moving electron have mass independent of their speed
(c) Moving electron can be diffracted
(d) Can be deflected by an electric field

163. The theory of relativity shows that Newtonian mechanics

(a) is always valid
(b) approximately valid for all velocity
(c) valid for velocity below velocity of light
(d) valid only for small velocity

164. Which one is not an assumption involved in Stroke's formula

(a) the medium is homogeneous

(b) no eddy currents or waves are set up in the medium due to motion of the body through it

(c) the medium is finite

(d) spherical body is perfectly rigid and smooth

165. The value of g is

(a) least at the equator (b) greatest at the equator
(c) same throughout (d) least at an altitude of 45°

166. The effect of the rotation of the earth on the weight of a body is that the apparent weight of the body is smaller than its true weight. How many times faster than the present speed would the earth have to rotate on the axis in order that the apparent weight of bodies at the equator be zero

(a) one (b) twice
(b) four (d) seventeen

167. The bodies kept loose on the equator would start leaving the earth's surface. This implies that

(a) the earth is at rest

(b) the earth has started rotating from north to south

(c) the speed of rotation is such that the centripetal force necessary to rotate the bodies lying on the equator would become greater than their weight

(d) the speed of rotation is such that the centripetal force necessary to rotate the bodies lying on the equator would become lesser than their weight

168. The critical velocity at which a coin of radius r can roll along a level surface while remaining upright is

(a) $\sqrt{gr}$ (b) $\sqrt{2gr}$
(c) $\sqrt{(2/3)\,gr}$ (d) $\sqrt{(1/3)\,gr}$

169. If the earth suddenly contracted to half its present radius, by how much would the day be decreased?

(a) 24 hrs (b) 12 hrs
(c) 6 hrs (d) 18 hrs

170. A man seated on a horizontal platform of a "joy-wheel" at a distance of 4.9 metres from its centre, slips if the angular velocity of the wheel exceeds 1 radians/sec. The co-efficient of friction between the man and the platform is

(a) 0.25 (b) 0.5
(c) 0.98 (d) 0.1

171. How many days would there be in a year if the distance between the earth and the sun were reduced to half of its present value? Assuming circular orbit
   (a) 365 days (b) 730 days
   (c) 129 days (d) 182.5 days

172. A solid circular disc rolls down an inclined plane without slipping, its accleration is given by
   (a) (2/3) g sinθ (b) (2/3) g cosθ
   (c) (1/3) g sinθ (d) g sinθ

173. A pitot tube is fixed in a water pipe line of area of cross section 200 sq cm. If the range of instrument indicates a pressure difference of 5 cms of water, which corresponds to a velocity of flow of 100 cm/sec, the rate of flow of water is
   (a) 1000 cc/sec (b) 2×10^4 cc/sec
   (c) 500 cc/sec (d) 10^5 cc/sec

174. The excess of pressure in a soap bubble of 2 mm radius and surface tension of soap solution being 30 dynes/cm is
   (a) 600 joules/sq cm (b) 600 dynes/sq cm
   (c) 600 gram/sq cm (d) 600 kg/sq cm

175. If the surface tension of soap solution is 40 dynes/cm. The amount of work done in blowing a soap bubble of area 1 sq cm is
   (a) 40 ergs (b) 20 ergs
   (c) 80 ergs (d) 120 ergs

2

THERMAL PHYSICS

176. Two systems are said to have equal temperatures if there is no change in any of their observed characteristics, when they are brought into contact with one another
   (a) true (b) false
   (c) don't know

177. The principle of thermal equilibrium often called the zeroth law of thermodynamics states that
   (a) if the heat content of a body A and B are each equal to the heat content of a third body then they are equal in temperature to each other
   (b) if the specific heat of A and B are each equal to the specific heat of a third body then the two bodies A and B are equal in temperature to each other

(c) if two bodies are each equal in temperature to a third body they are equal in temperature to each other

(d) if two bodies are each equal in temperature to a third body they have equal specific heat

178. First law of thermodynamics states that

(a) when work is transformed into heat or vice-versa, the quantity of work is mechanically equivalent to the quantity of heat

(b) work done has no relation with heat developed

(c) the quantity of work done is proportional to the quantity of heat developed

(d) the quantity of heat developed is proportional to the square of the quantity of work done

179. The value of joule's mechanical equivalent of heat is

(a) 41.86×10^7 ergs per calories
(b) 4.186×10^7 ergs per calories
(c) 4.186×10^5 ergs per calories
(d) 4.186×10^4 ergs per calories

180. In Jog falls assuming the water to fall from a height of 50 metres, the difference between the temperature of water at the top and bottom is ($J = 4.2 \times 10^7$ ergs/ calories)

(a) 10 degrees (b) 0.12 degrees
(c) 1 degrees (d) 0.012 degrees

181. One of the following is an example of reversible process

(a) work done against friction
(b) heat produced by the passage of a current
(c) melting of ice
(d) Joule Kelvin effect

182. One of the following is an example of irreversible process

(a) All isothermal and adiabatic changes
(b) melting of ice
(c) work done against friction
(d) peltier heating or cooling

183. The maximum possible efficiency of a heat engine working between temperature 27 degrees centigrade and 327 degrees centigrade is

(a) 47.1% (b) 50%
(c) 45% (d) 42.1%

184. Heat supplied to carnot's engine working between 27°C and 327°C is 1000 lb calories. Amount of heat converted

to useful work is

(a) 500 lb calories (b) 327.2 lb calories
(c) 617.4 lb calories (d) 445.127 lb calories

185. Heat cannot flow from a cold body to a hot body. The statement is

(a) a correct statement
(b) an incorrect statement
(c) heat can flow provided work is done on the cold body by some external energy and the statement is incorrect

186. Carnot's theorem states that

(a) no heat engine is more efficient than a reversible engine when working between the same two limits of temperature
(b) any heat engine can be more efficient than a reversible engine when working between the same two limits of temperature
(c) irrespective of the temperature limits a reversible engine is always less efficient than any other heat engine
(d) reversible heat engines working between the same temperature limits have different efficiency

187. Adiabatic expansion is one in which

(a) expansion takes place with addition of heat
(b) expansion takes place without addition of heat
(c) expansion takes place at constant temperature
(d) none of the above

188. In actual practice the efficiency of a heat engine ranges between

(a) 25—35% (b) 35—45%
(c) 30—50% (d) 5—25%

189. Isothermal expansion is one in which

(a) expansion takes place at constant pressure
(b) expansion takes place at constant temperature and pressure
(c) expansion takes place without the addition of heat
(d) expansion takes place at constant temperature

190. A diesel engine

(a) has a lower efficiency than Carnot and Otto engine
(b) has a higher efficiency due to a greater compression ratio
(c) has the same efficiency as compared to an Otto engine

191. Absolute thermodynamic temperature
    - (a) is defined by dividing the expansion of water into even degrees
    - (b) is independent of any particular substance
    - (c) is defined by dividing expansion of mercury into even degrees

192. The efficiency of a Carnot engine depends on the
    - (a) temperature of the source only
    - (b) temperature of both the source and the sink
    - (c) temperature of the sink alone
    - (d) working substance

193. If the temperature of the source is increased, the efficiency of a Carnot engine
    - (a) decreases
    - (b) increases
    - (c) does not change
    - (d) will be equal to the efficiency of a practical engine

194. If the temperature of the sink is decreased, the efficiency of a Carnot engine
    - (a) decreases
    - (b) increases
    - (c) remains same
    - (d) first increases and then decreases

195. Area inside the Carnot cycle represent
    - (a) heat taken to increase the temperature of the body
    - (b) useful work done
    - (c) energy loss due to leakage and is equivalent to magnetic hysterisis
    - (d) heat rejected by the system

196. The efficiency in the case of a Carnot and Otto cycle is given by

(a) $(T_1-T_2)/(T_1+T_2)$ (b) $(T_1+T_2)/T_1T_2$

(c) $(T_1-T_2)/T_1$ (d) $T_1T_2/(T_1+T_2)$

197. If P is the compression ratio then the efficiency of a Diesel engine is given by

(a) $\left(\frac{1}{P}\right)^{\gamma-1}$ (b) $P^{\gamma-1}$

(c) $1+P^{\gamma-1}$ (d) $1-\left(\frac{1}{P}\right)^{\gamma-1}$

198. A frictionless heat engine can be 100% efficient only if its exhaust temperature is

(a) equal to its input temperature
(b) less than its input temperature
(c) 0°C
(d) 0°K

199. The statement of the second law of thermodynamics is as follows
    (a) $\triangle U = Q - W$
    (b) It is possible for any cyclical machine to produce no other effect than to convey heat continuously from one body to another at a higher temperature
    (c) It is possible for any cyclical machine to produce no other effect than to convey heat continuously from one body to another at a lower temperature

200. The absolute boiling point of water
    (a) is the same whether measured on the perfect gas scale temperature or on the thermodynamic scale of temperature
    (b) is more on the perfect gas scale temperature than on the thermodynamic scale of temperature
    (c) is less on the perfect gas scale temperature than on the thermodynamic scale of temperature
    (d) can be measured only with a thermodynamic scale of temperature

201. A thermodynamic degree is defined as
    (a) the amount of heat required to raise the temperature of water through a degree centigrade
    (b) the difference in temperature between which a Carnot's engine should be worked to get energy equal to 1/100th of the energy obtained from Carnot's engine working between the temperature of boiling water and melting ice
    (c) a degree corresponding to a mercury scale

202. Boiling point of a liquid
    (a) decreases with pressure
    (b) increases with pressure
    (c) remains the same

203. When the pressure increases the melting point of water
    (a) decreases
    (b) increases
    (c) remains the same
    (d) increases first and then decreases

204. When the pressure increases the melting point of ice

(a) increases first and then decreases
(b) remains the same
(c) decreases
(d) increases

205. Bismuth expands when it solidifies from the liquid state. Applying pressure to a sample of Bismuth

(a) decreases its melting point
(b) increases its melting point
(c) does not affect its melting point
(d) may or may not affect its melting point depending upon the shape of the sample

206. In any process the maximum amount of heat that can be converted to mechanical energy

(a) depends upon the amount of friction present
(b) depends upon intake and exhaust temperature
(c) depends upon whether kinetic or potential energy is involved
(d) is 100%

207. Change in entropy in a completely reversible cycle is

(a) positive (b) negative
(c) zero (d) none of the above

208. In an irreversible cycle

(a) there is no gain in entropy
(b) there is no change in entropy
(c) there is loss of entropy
(d) there is always a net gain of entropy

209. Entropy

(a) is that thermal property of a body which remains constant during an adiabatic process when no heat energy is given or removed from
(b) is that thermal property of a body that varies
(c) the specific heat of a body
(d) none of the above

210. Change in entropy when 1 gm of ice at 0°C melts to water at 0°C is

(a) 2.93 cal/°C (b) 29.3 cal/°C
(c) 0.293 cal/°C (d) 0.0293 cal/°C

211. If 1 gm of water at 0°C is heated to water at 100°C the change in entropy is

(a) 3.12 cal/°C (b) 0.312 cal/°C
(c) 0.293 cal/°C (d) 0.0293 cal/°C

212. On a (T,S) diagram isothermals are lines
(a) parallel to the S axis (b) parallel to the T axis
(c) at an angle of 45° to S axis
(d) having slope of 0.8

213. On a (T, S) diagram adiabatics are lines
(a) having any inclination
(b) parallel to the T axis
(c) parallel to the S axis
(d) none of the above

214. On a (T, S) diagram the Carnot cycle is represented by a figure which is
(a) a parallellogram (b) a circle
(c) same as p-v diagram (d) a rectangle.

215. The quantity of heat which passes by conduction between two parallel surfaces of a slab of a substance in the steady state is
(a) directly proportional to the temp-difference between two surfaces
(b) directly proportional to the area of cross section of the slab
(c) directly proportional to the time for which heat passes and inversely proportional to the thickness of the slab
(d) all a, b and c

216. Thermal resistance is equal to the
(a) thermal conductivity
(b) square of the thermal conductivity
(c) reciprocal of the thermal conductivity
(d) square root of the thermal conductivity

217. Dimensions of thermal conductivity is
(a) $M^0 L^0 T^{-3} \theta^{-1}$ (b) $M^1 L^0 T^{-3} \theta^{-1}$
(c) $M^1 L^1 T^{-3} \theta^{-1}$ (d) $M^0 L^1 T^{-2} \theta^{-1}$

218. Thermal conductivity is
(a) the quantity of heat that flows in one second through a centimetre cube of a substance whose opposite faces are maintained at a temperature difference of 1°C
(b) specific heat of the substance
(c) the heat of vapourisation
(d) thermal capacity of the body

219. The quantity of heat required to raise the temperature of 1 gm of a substance by 1°C is called as

(a) heat of fission (b) heat of vapourisation
(c) specific heat
(d) mechanical equivalent of heat

220. Two slabs have, thermal conductivities K_1 and K_2 width d_1 and d_2 and temprature θ_1, θ_2 respectively. Then their interface temperature is given by

(a) $\left(\frac{K_1}{d_1}.\theta_1 + \frac{K_2}{d_2}.\theta_1\right) / \left(\frac{K_1}{d_1} + \frac{K_2}{d_2}\right)$
(b) $\left(\frac{K_1}{d_1}.\theta_1 - \frac{K_2}{d_2}.\theta_3\right) / \left(\frac{K_1}{d_1} - \frac{K_2}{d_2}\right)$
(c) $\left(\frac{K_1}{d_1}.\theta_1 \times \frac{K_2}{d_2}.\theta_2\right) / \left(\frac{K_1}{d_2} + \frac{K_2}{d_2}\right)$
(d) $\left(\frac{K_1}{d_1}.\theta_1 - \frac{K_2}{d_2}.\theta_2\right) / \left(\frac{K_1}{d_1} + \frac{K_2}{d_2}\right)$

221. In the Ingenhausz's experiment for comparing the coefficient of thermal conductivity of different metals, the length to which the wax melts along the wax coated bar is proportional to

(a) thermal conductivity of the material of the bar
(b) specific heat of the bar
(c) square root of the thermal conductivity of the material of the bar
(d) square root of the thermal conductivity of the bar

222. Newton's law of cooling states that the

(a) rate at which a body loses heat to its surroundings is proportional to the temp of the body
(b) rate at which a body loses heat to its surroundings is proportional to the temp of the surroundings.
(c) rate of loss of heat is independent of the temperature of the body or its surroundings
(d) rate at which a body loses heat to its surroundings is proportional to the temperature difference between the body and its surroundings

223. Tick the correct statement

(a) A perfectly black body is one which absorbs totally all the radiations of any wave length that fall on it.
(b) A black body when heated emits radiations of all possible wave lengths.

(c) the radiations emitted by a black body are known as black radiations or total radiations.
(d) all the above statements are correct.

224. According to Kirchhoff's law
(a) The product of emissive power and the absorptive power of all bodies is the same
(b) Emissive power of all bodies is equal to their absorptive power
(c) The ratio of emissive power and the absorptive power of all bodies is the same and is equal to the emissive power of a perfectly black body
(d) The emissive power of all bodies are equal to that of a perfectly black body

225. An inventor claims to have developed an engine working between 27°c and 227°c having an efficiency of 45%. The claim is
(a) correct (b) false
(c) possible under conditions

226. The amount of radiant energy in ergs E emitted per sqaure centimeter per second by a black body is directly proportional to
(a) $1/T$ (b) T^2
(c) T^4 (d) $1/T^4$

227. The wavelength of emitted radiation corresponding to the maximum energy is inversely proportional to the absolute temperature. The law is known as
(a) Stefan's law (b) Kirchhoff's law
(c) Prevost's theory (d) Wien's law

228. As the temperature of a black body is raised the wavelength corresponding to the maximum energy
(a) shifts towards the shorter wavelength
(b) shifts towards the longer wavelength
(c) remains the same

229. A body cools from 90°C to 60°C in 6 minutes when the surrounding temperature is 30°C. The temperature of the body after a further 6 minutes is
(a) 35°C (b) 45°C
(c) 50°C (d) 25°C

230. The value of Stefen's constant is
(a) 56.7×10^{-5} erg cm^{-2} sec^{-1} deg^{-4}
(b) 5.67×10^{-8} Wm^{-2} K^{-4}

(c) 5.67×10^{-4} erg cm^{-2} sec^{-1} deg^{-4}
(d) 567×10^{-8} Wm^{-2} K^{-4}

231. Bolometer is used for measuring

(a) high temperature
(b) specific heat
(c) thermal conductivity
(d) total heat radiation

232. The temperature of a black body of surface area 0.2 sq. m is 540°C. Then the wavelength of maximum monochromatic emission is

(a) 3.57×10^{-6} m
(b) 35.7×10^{-6} m
(c) 0.268×10^{-7} m
(d) 0.2×10^{-6} m

233. The intensity of radiation emitted by a black body is not uniformly distributed over the whole range of wavelength in the continuous spectrum emitted by it. The statement is

(a) correct
(b) incorrect
(c) correct under certain conditions

234. If c is the root mean square velocity and 'x' the density of the gas then according to kinetic theory of gases, pressure is given by

(a) $P = xc^2$
(b) $P = \frac{1}{3}xc$
(c) $P = \frac{1}{3}xc^2$
(d) $P = \frac{1}{3}\frac{c^2}{x}$

235. The pressure of a gas is equal to

(a) translational kinetic energy of the molecules in a unit volume
(b) 2/3 of the translational kinetic energy of the molecule in a unit volume
(c) 10% of the translational kinetic energy of the molecules in a unit volume
(d) its molecular density

236. Equal volumes of two gases at the same temperature and pressure

(a) have number of molecules according to their density
(b) have different number of molecules
(c) have same number of molecules
(d) cannot be said

237. Two gases of equal volume having densities x_1 and x_2 and mean square velocities c_1 and c_2 respectively are mixed up.

then their resultant pressure P is given by

(a) $P = x_1c_1 + x_2c_2$ (b) $P = x_1^2c_1^2 + x^2_2c_2^2$

(c) $P = \frac{1}{3}x_1c_1^2 + \frac{1}{3}x_2c_2^2$ (d) $P = \frac{c_1^2}{x_1^2} + \frac{c_2^2}{x_2^2}$

238. Mean square velocity is proportional to the
   (a) absolute temperature
   (b) square of the absolute temperature
   (c) square root of the absolute temperature
   (d) inverse of the absolute temperature

239. Pressure remaining constant, the temperature at which the mean square velocity of Hydrogen will be double of its velocity at NTP is

   (a) 1000°A (b) 273°A
   (b) 1002°A (d) 1092°A

240. When a gas is compressed
   (a) its temperature decreases
   (b) its temperature remains the same
   (c) the internal energy of gas increases and thus the kinetic energy and hence absolute temperature increases
   (d) none of the above

241. If n is the number of molecules per c.c and d the diameter of each molecule. Then mean free path of the molecules of gas is given by

   (a) πnd^2 (b) π/nd^2
   (c) πnd (d) $1/\pi nd^2$

242. Co-efficient of Viscocity of a gas is proportional to the
   (a) square of the absolute temperature
   (b) square root of the absolute temperature
   (c) absolute temperature
   (d) inverse of the absolute temperature

243. At N.T.P. one c.c of a gas contains
   (a) 2.7×10^{12} molecules
   (b) 27×10^{12} molecules
   (c) 0.27×10^{12} molecules
   (d) 0.027×10^{12} molecules

244. The Maxwell's law of distribution of velocity establishes that

(a) in a steady state the number of molecules with a given velocity do not remain constant
(b) in a steady state the number of molecules with a given velocity remain constant
(c) all molecules have uniform velocity
(d) number of molecules having infinite velocity is greater than number of molecules at rest

245. Kinetic energy per molecule if K = Boltzman's constant is given by
(T = absolute temperature)

(a) KT (b) 1/2 KT
(c) 3 KT (d) 3/2 KT

246. Ratio of specific heat for monoatomic gases is

(a) 1.56 (b) 0.66
(c) 2.00 (d) 1.66

247. A perfect gas is that which

(a) strictly obeys Boyle's law only
(b) obeys Charle's law only
(c) do not obey gas laws
(d) strictly obeys all gas laws

248. The ratio of specific heats for a diatomic gas is

(a) 1.4 (b) 0.4
(c) 2.4 (d) 1.0

249. Two lead spheres at the same temperature having radius in the ratio 1 : 2. The ratio of their heat contents is

(a) 1 : 1 (b) 1 : 2
(c) 1 : 3 (d) 1 : 8

250. The triple point of a substance is the temperature and pressure at which

(a) the solid and liquid phases are in equilibrium
(b) the liquid and gaseous phases are in equilibrium
(c) the solid, liquid and gaseous phases are in equilibrium
(d) the solid does not melt, the liquid does not boil and gases does not condense

251. The gas exerts pressure on the walls of the container because the gas molecules

(a) have finite size
(b) obeys Boyle's law

(c) have momentum
(d) collide with one another

252. For measuring very high temperature of the order of 3000°C one can use

(a) optical pyrometer
(b) liquid in glass thermometer
(c) platinum resistance thermometer
(d) mercury thermomter

253. Van der waal's equation states that

(a) $(P-a/v^2)(v-b)=RT$
(b) $(P+a/v^2)(v-b)=RT$
(c) $(P+a/v^2)(v+b)=RT$
(d) $(P+a/v^2)(v+b)=-RT$

254. For $b=10^{-3}$ critical volume of a gas is given by

(a) 2×10^{-3} gm mol vol
(b) 10^{-3} gm mol vol
(c) 3×10^{-3} gm mol vol
(d) $1/10^{-3}$ gm mol vol

255. Critical temperature of a gas in terms of constants a, b & R is given by

(a) $\frac{a}{Rb}$ (b) $\frac{8Rb}{27a}$
(c) $\frac{b}{Ra}$ (d) $\frac{8a}{27Rb}$

256. For $a=10^{-5}$ and $b=10^{-3}$ critical pressure of a gas is given by

(a) 3.7 atmosphere (b) 0.37 atmosphere
(c) 37 atmosphere (d) 370 atmosphere

257. An adiabatic is represented by the equation

(a) $TP^{(1-\gamma)/\gamma} = \text{constant}$
(b) $P^{(2-\gamma)/\gamma}/T = \text{constant}$
(c) $T^{\gamma}P^{(1-\gamma)} = \text{constant}$
(d) $PT^{\gamma} = \text{constant}$

258. A quantity of air at NTP is suddenly compressed to 1/5th of its volume. For $\gamma=1.4$. The temperature attained by air is

(a) 520°A (b) 500°A
(c) 600°A (d) 400°A

259. During an adiabatic expansion the increase in volume is associated with

(a) decrease in temperature and decrease in pressure
(b) increase in pressure and decrease in temperature
(c) increase in pressure and increase in temperature
(d) decrease in pressure and increase in temperature

260. Work done by an expanding gas under adiabatic condition results in

(a) no change in temperature
(b) temperature increases
(c) temperature decreases
(d) temperature increases first and then decreases

261. Work done during an isothermal expansion is given by

(a) $RT \times V_2/V_1$
(b) $RT \log_{10} V_2/V_1$
(c) $RT \log_e V_2/V_1$
(d) $RT \log_e V_1/V_2$

262. A gram molecule of a gas at 127°C expands isothermally until its volume is increased 10 times. If $R = 8.3 \times 10^7$ ergs/gm molecule/°C, the amount of work done is given by

(a) 5×10^{10} ergs
(b) 7.6×10^{10} ergs
(c) 6.8×10^{10} ergs
(d) 9.1×10^{10} ergs

263. Amount of work done in order to expand a gas is 4.2×10^{10} ergs. Heat absorbed by the gas, if $J = 4.2 \times 10^7$ erg cal^{-1}, in order to maintain isothermal condition is

(a) 500 cal
(b) 420 cal
(c) 840 cal
(d) 1000 cal

264. Under adiabatic compression the increase in temperature of a gas is proportional to

universal gas constant
(b) work done on the gas
(c) ratio of the two specific heat
(d) pressure to which gas is compressed

265. Joule-Thomson effect is

(a) cooling produced when gas is compressed
(b) cooling produced when gas is expanded adiabatically
(c) cooling produced when gas is compressed isothermally
(d) cooling produced when gas is allowed to expand through a narrow orifice

266. Temperature of inversion, the temperature at which Joule-Thomson effect changes sign is given by

(a) $T_i = Rb/2a$ (b) $T_i = 2aRb$
(c) $T_i = 2a/Rb$ (d) $T_i = 2Ra/b$

267. Hydrogen and Helium show a heating effect at ordinary temperature as
    - (a) the temperature inversion of these two gases are much below the ordinary room temperature
    - (b) the temperature inversion of these two gases are much above the ordinary room temperature
    - (c) they have identical molecular structure
    - (d) none of the above

268. The perfect gas equation $PV = RT$ (Where R is the universal gas constant) holds good for

(a) 1 c.c of gas (b) any volume of gas
(c) 1 gm of gas (d) 1 gm mole of gas

269. If R is the gas constant per mole of a gas and N is the Avogardo number then Boltzman's constant is given by

(a) RN (b) R/N
(c) N/R (d) (3/2)RN

270. The specific heat of a gas at constant volume
    - (a) is equal to the specific heat at constant pressure
    - (b) is less than the specific heat at constant pressure
    - (c) is not related to the specific heat at constant pressure
    - (d) is greater than the specific heat at constant pressure

271. The product of mass and specific heat of a substance is known as

(a) water equivalent (b) atomic heat
(c) latent heat (d) quantity of heat

272. If the sun's central core called the photosphere is assumed to be black, then its temperature known as black body temperature of the sun comes to be

(a) 6500°A (b) 7564°A
(c) 5780°A (d) 4576°A

273. The amount of heat energy received from sun by a unit area of a black body held normally to sun's rays per second and at a mean distance of earth called solar constant, has a value of

(a) 1.937 cal/sq cm/min (b) 2.365 cal/sq cm/min
(c) 1.186 cal/sq cm/min (d) 0.654 cal/sq cm/min

274. Dulong and Petit's law states that the product of the atomia weight of an element in the solid state and its specific ehtc

is constant. Its value for solids is 6.4 and for elements in gaseous state is about 3.4. For liquid it is

(a) 4.5 (b) 5.6
(c) 3.26
(d) liquids do not obey this law

275. The rate of heat radiation depends on

(a) nature of the radiating surface
(b) temperature of the radiating surface
(c) both (a) and (b)
(d) none of the above

276. Brownian motion, which tells that the suspended particles show a continuous random motion when viewed under a microscope, offers a striking experimental test of

(a) Kinetic theory hypotheses
(b) radiation phenomenon
(c) conduction phenomenon
(d) convection phenomenon

277. If there are about 3×10^{19} molecules/cm^3 and the effective molecular diameter of air is 2×10^{-8} cm, the magnitude of the mean free path for an air molecule at 0° C and one atm-pressure is

(a) 2×10^{5} cm (b) 2×10^{-6} cm
(c) 2×10^{-5} cm (d) 2.1×10^{-2} cm

278. If the average speed of air molecule is 1×10^{5} cm/sec and the magnitude of mean free path is 1×10^{-5} cm, then the collision frequency for air molecule is

(a) 1 (b) 1×10^{10}
(c) 1×10^{-10} (d) 1×10^{-5}

279. As we move vertically up in the earth's atmosphere the magnitude of mean free path of air molecules

(a) increases (b) decreases
(c) remains same

280. The average translational kinetic energy per molecule in a gas at room temperature is

(a) 6.21×10^{-10} joule/molecule
(b) 3.88×10^{-2} joule/molecule
(c) 6.21×10^{-23} joule/molecule
(d) 6.21×10^{-21} joule/molecule

281. According to Maxwellian distribution of speed, the probability that a particle has precisely stated speed is

(a) 1 (b) 0.5
(c) zero (d) greater than 0.5

282. From what height must a block of ice be dropped in order that it may be completely melted, if 50 % of energy of fall is retained by ice

(a) 7.94×10^5 cm (b) 6.86×10^6 cm
(c) 5.98×10^7 cm (d) 6.05×10^4 cm

283. Pressure of a gas is

(a) force per unit area (b) force per unit volume
(c) force per unit length

284. Transmission of heat by molecular collision is

(a) conduction (b) convection
(c) radiation (d) scattering

285. Elongation of a rod when heated is

(a) proportional to its original length
(b) independent of its original length
(c) inversely proportional to its original length

286. The specific heat of a solid

(a) remains constant with rise in temperature
(b) decreases with rise in temperature
(c) increases with rise in temperature and tends to zero as the absolute zero of temperature is approched

287. The specific heat of liquid

(a) remains constant with increase in temperature
(b) increases with temperature
(c) decreases with temperature
(d) none of the above

288. The specific heat of water

(a) increases with rise of temperature
(b) decreases with rise of temperature
(c) remains constant
(d) first decreases, reaches a minimum value and then increases

289. Water has minimum specific heat at

(a) 4°C (b) 0°C
(c) 273°C (d) 37°C

290. Water has specific heat of 1.0 at

(a) 0°C (b) 4°C
(c) 15°C (d) 37°C

291. The specific heat of all gases increases with temperature at high temperature and decreases at low temperature. Exception to this rule is

(a) none (b) monoatomic gases
(c) diatomic gases (d) oxygen

292. 6 Kg of ice at—10°C are added to 6 Kg of water at +10°C the temperature of resulting mixture is

(a) −10°C (b) 0°C
(c) 3.3°C (d) 10°C

293. Calorific value is

(a) water equivalent of the fuel
(b) the thermal equivalent of the fuel
(c) the quantity of heat produced when a known weight of the fuel is completely burnt
(d) the specific heat of the fuel

294. Volume remaining constant the pressure of a given mass of gas varies as the absolute temperature, this is a statement of

(a) Boyle's law (b) Charles's law
(c) Regnault's law (d) Maxwell's law

295. Tick the correct statement. Advantage of using gases as thermometric substances is that the

(a) gasses have a small co-efficient of expansion
(b) expansion of a gas is irregular
(c) gases can be obtained easily in a pure state
(d) the perfect gas scale of temperature and thermodynamic scale of temperature are not identical

296. Callender's thermometer is

(a) constant volume air thermometer
(b) constant pressure compensated thermometer
(c) mercury thermometer
(d) such a thermometer does not exist

297. The co-efficient of absolute expansion of a liquid can be determined accurately by a method due to

(a) Maxwell (b) Callender
(c) Kirchhoff (d) Renault

298. The range of the Chappius constant volume Hydrogen and Helium thermometer has a useful temperatue range of

(a) −25° to 400°C (b) −600° to 1600°C
(c) −150° to 780°C (d) 0° to 140°C

299. The pressure of air in a constant volume gas thermometer is 70 cm of mercury and 100 cm of mercury at 0°C and 100°C respectively. When the bulb is placed in a hot liquid bath the pressure is 95 cm. The temperature of the bath is

(a) 45°C (b) 100°C
(c) 50°C (d) 0°C

300. Lead and zinc of equal size are heated so that they have same heat content. It implies that

(a) they are heated to the same temperature
(b) have same specific heat
(c) the two have different temperature in such a way that their heat content is the same
(d) the two cannot have same heat content at any stage

301. One gram of water at 100° C is heated to convert it to steam. The amount of heat required is

(a) 560 cal (b) 455 cal
(c) 80 cal (d) 536 cal

302. Latent heat in general is defined as the

(a) quantity of heat required to raise the temperature of one gram of a substance through 1 degree centigrade.
(b) quantity of heat required to transform 1 gm of water at 0°C to ice at 0°C.
(c) quantity of heat required to transform 1 gm of water at 100°C to steam at 100°C
(d) quantity of heat absorbed or released in an isothermal transformation of phase

303. At the melting and boiling point of a substance, the addition of heat causes

(a) change in temperature
(b) change of state
(c) change of state without change in temperature
(d) change of state with change in temperature

304. The relationship between three scales of temperature namely Centigrade, Fahrenheit and Reaumur scale is

(a) $\frac{C}{5}=\frac{F-32}{9}=R$ (b) $\frac{C}{5}=\frac{F-32}{9}=\frac{R}{2}$

(c) $\frac{C}{5}=\frac{F\ 32}{9}=\frac{R}{4}$ (d) $\frac{C}{9}=\frac{F-32}{5}=\frac{R}{4}$

305. In a platinum resistance thermometer the resistance at 100°C is 20% more than at 0°C. The thermometer is placed in a bath of liquid. Now the resistance read is 10% more than the resistance at 0° C. The temperature of the bath is

(a) 50°C (b) 96°C
(c) 25°C (d) 45°C

306. Co-efficient of apparent expansion of the liquid is

(a) sum of co-efficient of real expansion of liquid and co-efficient of expansion of vessel
(b) twice the co-efficient of real expansion of liquid
(c) difference of co-efficient of real expansion of liquid and co-efficient of expansion of containing vessel
(d) twice the co-efficient of expansion of the containing vessel

307. Co-efficient of linear expansion, co-efficient of superficial expansion and co-efficient of volume expansion are related to each other by

(a) $\alpha : \beta : \gamma :: 2 : 3 : 1$ (b) $\beta : \alpha : \gamma :: 2 : 1 : 3$
(c) $\alpha : \beta : \gamma :: 1 : 3 : 2$ (d) $\gamma : \alpha : \beta :: 3 : 2 : 1$

308. Thermal capacity of a body is

(a) the amount of heat required to raise the temperature of 1 gm of the body through one degree centigrade
(b) the amount of heat required to raise the temperature of the body through one degree centgrade
(c) is not equal to water equivalent of the body
(d) none of the above

309. Two blocks of lead one twice as heavy as the other, are both at 50°C. The ratio of heat content of the heavier block to that of the lighter block is

(a) 1/2 (b) 1
2 (d) 4

310. From what height must a lump of ice at 0°C fall in order o melt itself (J = 4.2 Joules/calarie, g = 980 cms/sec

(a) 50 meters (b) 34.2 meters
(c) 44 meters (d) 64 meters

311. At a very low temperature cotton,

(a) becomes brittle (b) begins to flouresce
(c) does not flouresce (d) cannot be spun into thread

312. The principle of adiabatic demagnetisation is used to
   (a) demagnetise a magnet
   (b) generation of electricity
   (c) liquifaction of gas
   (d) purifying a gas

311. A Thermistor is a
   (a) Thermo couple (b) thermometer
   (c) thermos flask (d) miniature resistance

314. What should be the shape of an ideal thermometer
   (a) spherical (b) cylindrical
   (c) cubical (d) rectangular

315. Water percolates into the soil and freezes. The soil
   (a) cools down (b) loosens
   (c) becomes hot (d) cannot be said

316. A piece of metal with a circular hole is heated. If the metal expands on heating the diameter of the hole
   (a) increases
   (b) decreases
   (c) increases or decreases depending upon the diameter of the hole
   (d) increases or decreases depending on the kind of metal

317. Ice is slippery when a man walks on it for
   (a) its surface is smooth
   (b) there is no friction
   (c) increase of pressure causes ice to melt
   (d) it is very chill

318. Food can be cooked quicker in a pressure cooker because
   (a) no heat is lost
   (b) high pressure steam has high temperature
   (c) steam remains within the cooker
   (d) it is made of metal

319. The standard scale of temperature is
   (a) the mercury scale
   (b) the platinum resistance scale
   (c) the gas scale
   (d) none of the above

320. Andrews isothermal helps to measure
    (a) Boyles temperature
    (b) critical temperature
    (c) temperature of inversion
    (d) boiling point of a liquid

321. In kinetic theory of gases, one assumes that the collisions between the molecules are
    (a) perfectly elastic (b) perfectly inelastic
    (c) partly elastic (d) partly inelastic

322. Root mean square velocity of air molecules at room temperature is 4.0×10^4 cm/sec. Root mean square velocity will be 8.0×10^4 cm/sec at
    (a) 1000°A (b) 1200°A
    (c) 800°A (d) 1000°A

323. The one process which needs maximum amount of heat is
    (a) 1 gm ice at—10°C to 1 gm of water at+10°C
    (b) 1 gm of water at 98°C to 1 gm of steam at 108°C
    (c) 1 gm of water at 40°C to 1 gm of water at 80°C
    (d) 1 gm of water at+10°C to 1 gm of ice at−10°C

324. The method used to find the ratio of the two specific heat of a gas is
    (a) Callender and Barnes continuous flow method
    (b) Regnault method
    (c) Andrews method
    (d) Clement and Desorme's method

3

OPTICS

325. Velocity of light in vaccum is
    (a) Zero (b) 3×10^5 Km/S
    (c) 3×10^8 Km/S (d) 3×10^7 Km/S

326. Images formed by a plane mirror
    (a) is always virtual
    (b) is always real
    (c) can be either real or virtual
    (d) non of the above

327. To view a full image of an object of height 160 cms the minimum size of plane mirror required is

(a) 160 cms
(b) 80 cms
(c) 320 cms
(d) 40 cms

328. The incident ray being fixed, if the mirror is rotated through an angle of 10 degrees, the reflected ray is rotated through an angle of

(a) 10 degrees
(b) 5 degrees
(c) 20 degrees
(d) 30 degrees

329. Ray of light are incident on a plane mirror at 45 degrees. At what angle should a second plane mirror be placed, such that the rays emerge parallel to the incident rays

(a) 45 degrees to the first mirror
(b) 90 degrees to the first mirror
(c) Parallel to the first mirror
(d) 22.5 degrees to the first mirror

330. Velocity of light is.

(a) greater in denser media
(b) greater in rarer media
(c) independent of the nature of the media

331. The frequency of visible light is of the order of

(a) 10^5 Hz
(b) 10^8 Hz
(c) 10^{15} Hz
(d) 10^{12} Hz

332. Fermat's principle states that

(a) light chooses a path of least time
(b) light chooses a random path
(c) light bends around corners
(d) None of the above

333. Snell's Law

(a) gives us the definition of refractive index of a medium
(b) tells us that light travels in a path of least time
(c) light bends around corners
(d) tells us that angle of incidence is equal to angle of reflection

334. A man is standing at a distance of 5 meters from a mirror the distance between his image and himself is

(a) 15 meters
(b) 5 meters
(c) 10 meters
(d) 5.5 meters

335. According to Huygan's Principle

(a, light travels in a straight line
(b) all points on primary wave front are considerd to be centers of disturbances
(c) light bends around corners
(d) none of the above

336. An object is moved towards the mirror at a rate of 5 meters/sec How fast is the distance between its image and it is reduced

(a) 20 meters/sec (b) 5 meters/sec
(c) 2.5 meters/sec (d) 10 meters/sec

337. Two lamps A and B of luminous intensities 2Cd and 8 Cd respectively are placed 1 meters apart. Where should the screen be placed on the line joining them so that the illumination due to the two lamp may be same

(a) 1/4 meters from A (b) 1/3 meters from B
(c) 1/3 meters from A (d) 3/4 meters from B

338. According to Corpuscular theory

(a) the molecules and atoms of a source of light are in a state of vibration
(b) velocity of propagation of EM waves is the same as that of light
(c) lights instead of being a continuous stream of electro magnetic waves, consists of pockcts of energy or quanta
(d) lights consists of minute corpusceles in rapid motion

339. Two plane mirrors are inclined at an angle of "x" radians to each other. "P" is an object placed between the mirrors, the total number of images formed is given by

(a) $n=\frac{2\pi}{x}$ (b) $n=\frac{2\pi}{x}-1$

(c) $n=\frac{2\pi}{x}+1$ (d) $n=\frac{\pi}{x}-1$

340. The visible spectrum extends from about

(a) 4×10^{-7} meters to 7×10^{-7} meters
(b) 10^{-7} meters to 3×10^{-7} meters
(c) 9×10^{-7} meters to 15×10^{-7} meters
(d) 16×10^{-7} meters to 25×10^{-7} meters

341. Deviation of a ray of light produced by reflection from two inclined mirrors is

(a) independent of the angle between the two mirrors
(b) independent of the angle of incidence
(c) dependent upon the angle of incidence
(d) dependent upon both the angle of incidence and angle between the two mirrors

342. Headlight of a car is fitted with ——————in order to obtain parallel ligh rays

(a) convex mirror
(b) concave mirror
(c) convex lens
(d) concave mirror in front of the head lamp

343. The path difference corresponding to a phase difference of $\frac{\pi}{2}$ is

(a) λ (b) $\lambda/2$
(c) $\lambda/4$ (d) 2λ

344. If the distances of an object and its image from the focus of a mirror are respectively 8 cms and 2 cms, then the focal length of the mirror is

(a) 4 cms (b) 6 cms
(c) 8 cms (d) 2 cms

345. If 'x' is the distance of an object from the focus and 'y' is the distance of the image from the focus then the relation between the focal length 'F', x and y is

(a) $F=xy$ (b) $F=x/y$
(c) $F=x+y$ (d) $F^2=xy$

346. Spherical aberration in a spherical mirror can be removed

(a) by limiting the number of rays by using a stop
(b) by using a ellipsoidal mirror
(c) by using a parabolic mirror
(d) by using any of the above three method

347. Rotation of a plane mirror is put to use in

(a) Finding the angular deflection of the moving part of an instrument
(b) is not a useful phenomena
(c) in sextent
(d) in spectroscope

348. The distance of the object from a concave mirror of focal length 10 cms, for which a virtual image twice its height is formed, is

(a) 10 cms (b) 20 cms
(c) 5 cms (d) 15 cms

349. An object is placed very close to a concave mirror, the image formed is

(a) virtual, Errect and enlarged
(b) virtual, Inverted and reduced
(c) Real, Errect and reduced
(d) Real, Inverted and enlarged

350. Tick the wrong statement

(a) The ratio of the sin of the angle of incidence to the sin of angle of reflection for any two given media is the index of refraction
(b) The absolute refractive index of a medium is the ratio of velocity of light in vaccum to its velocity in the media
(c) The velocity of light in a medium is inversly proportional to its optical density.
(d) The refractive index of solids, liquids, and gases are independent of density and temperature.

351. The optical length of a ray of light of length l in a medium of refractive index is defined as

(a) μl (b) μ/l
(c) l (d) none of above

352. A piece of white glass placed in water is visible because

(a) water is transparent
(b) due to the difference in their refractive indices
(c) of the colour of the glass
(d) none of the above

353. For a given angle of incidence the displacement of the ray is dependent upon

(a) thickness of the medium
(b) refractive index of the medium
(c) both (a) and (b)

354. A coin placed at the bottom of a beaker containing water of refractive index μ to a height 'h' when viewed from top would appear to be raised by 'H'. H is given by the relation

(a) $\frac{\mu+1}{\mu}\times h$ (b) $\frac{\mu-1}{\mu}\times h$

(c) $\frac{\mu-1}{\mu+1}\times h$ (d) $\frac{\mu-1}{\mu h}$

355. The unit of illumination is

(a) Photon (b) luman
(b) Candella (d) Lux

356. Find the true statement

(a) refractive index of a material is dependent upon the wavelength of light
(b) $\mu = A + B/\lambda^2$ where A & B are constant
(c) Both (a) & (b) are correct statements
(d) $\mu = A - B/\lambda$

357. Total internal reflection takes place when

(a) the angle of incidence is greater than the critical angle
(b) the angle of incidence is less than the critical angle
(c) the angle of incidence is 30°
(d) the angle of incidence is 45°

358. The relationship between refractive index of three medias in parallel is

(a) $({}_1\mu_2 \times {}_2\mu_3)/{}_3\mu_1 = 1$ (b) ${}_1\mu_2 \times {}_2\mu_3 = {}_3\mu_1$
(c) ${}_1\mu_2 \times {}_2\mu_3 = {}_1\mu_3$ (d) ${}_1\mu_2 \times {}_1\mu_3 = {}_2\mu_3$

359. The refractive index of water with respect to air is 1.33 and that of glass is 1.5. The refractive index of glass with respect to water is

(a) 1.895 (b) 1.128
(c) 2.85 (d) 0.17

360. When a ray of light passes from a denser medium to rarer medium the ray of light

(a) bends towards normal
(b) bends away from normal
(c) passes unchanged

361. The power of lens in dioptres

(a) is its focal length in meters
(b) is the reciprocal of its length in centimeters
(c) is the reciprocal of its length in meters
(d) is its focal length in centimeters

362. Principle points

(a) are the points on the principle axis for which the lens has a negative magnification of unity
(b) are the focal points

(c) are the points on the principle axis for which the lens has a positive magnification of unity

(d) none of the above

363. The power of lens which is the reciprocal of focal length, is also given by the formule in terms of refractive index and radius of curvature

(a) $(\mu-1)(1/R_1+1/R_2)$

(b) $\mu(1/R_1-1/R_2)$

(c) $\mu(R_1+R_2)/R_1$

(d) $(\mu-1)(1/R_1-1/R_2)$

364. A convex Lens of focal length 'f' is immersed in a liquid (μ of liquid less than μ of glass) Its focal length

(a) increases (b) decreases

(c) remains constant (d) none of the above

365. An air bubble inside water is an example of

(a) a convex lens

(b) a plane mirror

(c) a plane convex lens

(d) concave lens

366. The minimum distance between an object and its real image in a convex lens is

(a) 2.5 f (b) 2 f

(c) 4 f (d) f

367. Two convex lens of focal length f_1 and f_2 are placed separated by a distance of d. This combination will have a focal length of

(a) $1/f=1/f_1-1/f_2+d/f_1f_2$

(b) $f=1/f_2-1/f_1+f_1f_2/d$

(c) $1/f=1/f_1+1/f_2+d/f_1f_2$

(d) $1/f=1/f_1+1/f_2-d/f_1f_2$

368. Two convex lens of focal length f used in combination become telescopic when the distance between them is

(a) f (b) 4f

(c) 2f (d) f/2

369. A convex lens of focal length 3 cms is placed at a distance from another convex lens of focal length 1 cms. If their combination has a focal length of 1.5 cm the distance between the two is

(a) 1 cms (b) 2 cms

(c) 3 cms (d) 4 cms

370. Two converging lens of focal length 'f' are combined & placed in contact. The focal length of the combination is

(a) f (b) 2f
(c) f/2 (d) 3f

371. A convex lens of focal length 'F' and a concave lens of focal length 'f' are placed in contact. The focal length of the combination is thus

(a) (f+F) (d) (f—F)
(c) fF/(f—F) (d) fF/(F+f)

372. One side of a convex lens is silvered. This combination forms a concave mirror combination. Their combination has focal length, (R_2 is the radius of curvature of mirror)

(a) $1/f=2/(R_2-f_1)$ (b) $f=(R_2+f_1)/2$
(c) $1/f=2f_1/R_2$ (d) $1/f=2f_1-R_2$

373. Lens makers formula

(a) is applicable to a very thin lens of a very small aperture
(b) is applicable to all forms of lens
(c) apart from being applicable to very thin lenses is applicable to other lenses under certain condition
(d) none of the above

374. A convex lens, two cms thick, has a radius of curvature 4 cms and 5 cms. If the refractive index of lens is 1.5 cms, the focal length of the lens is

(a) 15 cms (b) 30 cms
(c) 24 cms (d) 22.5 cms

375. A plano-convex lens 1.0 cms thick has radius of curvature of 10 cms and refractive index 1.5, its focal length is

(a) 5 cms (b) 15 cms
(c) 25 cms (d) 20 cms

376. The variation in focal length of a lens when we pass from the central portion to the perphery is called

(a) spherical aberration (b) astigmatism
(c) coma (d) chromatic aberration

377. A beam of monochromatic light is passed from one medium to another. Which one of the following quantity does not change

(a) velocity (b) frequency
(c) wave length

378. The condition that must be satisfied in order that a combination of two lenses of focal length f_1 and f_2 at a distance 'd' cms apart be achromatic is
   (a) $d=(f_1+f_2)$ (b) $d=(f_1+f_2)/2$
   (c) $d=(f_1-f_2)/2$ (d) none of the above

379. An achromatic doublet consists of
   (a) a convex lens of large focal length and a concave lens of small focal length
   (b) a concave lens of crown glass of large focal length and a convex lens of flint glass of small focal length
   (c) a crown glass convex lens of small focal length and a flint glass concave lens of large focal length
   (d) none of the above

380. Longitudinal chromatic aberration is
   (a) Dispersive power/Mean Focal length
   (b) Mean Focal length
   (c) Dispersive power
   (d) Dispersive power x Mean Focal length

381. Coma differs from spherical aberration in one of the following respect. Tick appropriate answer
   (a) Coma is measured laterly, while spherical aberration is measured longitudinally
   (b) The circles formed in coma are cometic, while those in spherical aberration is measured longitudinally
   (c) Coma is measured longitudinally, while spherical aberration is measured laterally
   (d) both (a) and (b)

382. The defect in image due to oblique centric rays falling on the lens is called
   (a) astigmatism
   (b) coma
   (c) curvature of the image field
   (d) spherical aberration

383. Angular dispersion is
   (a) difference in the deviation for green and white light
   (b) The deviation of violet light
   (c) the deviation of red light
   (d) the difference in the deviation for violet and red light

384. Dispersive power of the material of the prism is
   (a) $(\mu_v-\mu_r)/(\mu-1)$ (b) $(\mu_v+\mu_r)/(\mu+1)$
   (c) $\mu_v\mu_r/\mu$ (d) $(\mu_v-\mu_r)/\mu$

385. A beam of white light is passed through a prism. The emergent rays are passed through another prism of higher refractive index. The emergent light of the second prism is
   (a) multichromatic (b) monochromatic
   (c) white

386. In a spectrum red colour is deviated to a lesser extent than all the colours because its velocity is
   (a) greater than all the other colours
   (b) less than all the other colours
   (c) average of all the other colours
   (d) none of the above

387. Two sources of light are coherent if they emit rays of
   (a) same wavelength
   (b) same amplitude of vibration
   (c) same wavelength with constant phase difference
   (d) same wavelength and amplitude

388. Dispersion is the
   (a) splitting of white light into its component colours
   (b) propagation of light in straight line
   (c) bending of beam of light when it goes from one medium to another
   (d) reflection of light from a mirror

389. Flint glass has greater dispersive power and refractive index than crown glass. For no dispersion by the combination
   (a) the angle of the flint glass prism should be the same as that of crown glass prism
   (b) the angle of the flint glass prism must be greater than that of crown glass prism
   (c) the angle of the flint glass prism must be less than that of the crown glass prism

390. The blurring of the image due to dispersion in a lens is called
   (a) Spherical aberration
   (b) Chromatic aberration
   (c) Astigmatism
   (d) Curvature of the image field

391. If the incident rays are very oblique
   (a) Astigmatism becomes predominant
   (b) Spherical aberration becomes predominant

(c) Both astigmatism and spherical aberration appear

(d) none of the above

392. Mark the correct statement

(a) Formation of rainbows is an example of dispersion

(b) If the light before emerging from the drops undergoes only one internal reflection it gives rise to primary rainbow

(c) If two internal reflections take place before the light emerges a secondary rainbow is produced

(d) All the above three statements are correct

393. The function of field lens of an eye piece is

(a) Field lens with relatively large aperture helps increase the field of view for the observer

(b) Field lens in conjugation with eye lens reduces spherical aberration

(c) both (a) and (b)

(d) eye piece comprises of only one lens

394. Achromatic Prism is

(a) a combination of two prisms of different materials

(b) a prism made of flint glass

(c) a prism made of crown glass

(d) a combination of two prisms of same material

395. In Huygen's eye piece

(a) the focal length of the field lens is equal to the focal length of the eye piece

(b) the focal length of the field lens is three times the focal length of the eye lens

(c) the focal length of the eye lens is three times the focal length of the field lens

(d) comprises of a plane convex lens

396 A Ramsden's eye piece

(a) consists of two plano-convex lenses having same focal length

(b) uses one plano-convex lens

(c) consists of lenses with different focal length

(d) consists of a plano-convex lens and a concavo-convex lens

397. Average kinetic energy of a vibrating particle with amplitude 'a' and period of vibration 'T' is

(a) $m\pi^2a^2/T^2$ (b) $m\pi a/T$
(c) $m^2\pi a/T$ (d) $ma/\pi T$

398. In non localised fringes the distance of the nth bright band from the centre is given by

(a) $Xn=(D/d)\times n\lambda$ (b) $Xn=(2D/d)\times n\lambda$
(c) $Xn=(D/2d)\times n\lambda$ (d) $Xn=(D/d)\times n\lambda^2$

399. The distance between two consecutive bright band in fringes is

(a) $D\lambda/d$ (b) $2Dd\lambda$
(c) $2D\lambda/d$ (d) $D\lambda/2d$

400. A thin film of refractive index μ is placed in the path of one of interfering beam in a bi-prism arrangement. The shift of central fringe is given by

(a) there is no shift in Central fringe
(b) $(\mu-1)\times t\times D/2d$
(c) $\mu\times t\times D/2d$
(d) $(\mu-1)D/2d$

401. The intensity of the dark band in the interference pattern becomes zero when two waves

(a) of light are monochromatic
(b) are of the same frequency
(c) are of same amplitude
(d) travel in opposite direction

402. Light emission stops when the incident light is cut off. This phenomenon takes place in

(a) phosphorescence (b) fluorscence
(c) luminouscence (d) efforescence

403. In Fluorescence

(a) the substance absorb radiation of shorter wave-length and re-emit radiation of different wave-length
(b) the substance absorb radiation of longer wave-length and re-emit radiation of shorter wave-length
(c) the substance absorb radiation of shorter wave-length and re-emit radiation of longer wave-length
(d) none of the above

404. White light is incident at an angle α on two parallel glass plates of refractive index μ and thickness 't'. Maximum number of dark fringes is given by the formula

(a) $2\mu t\cos\alpha=n\lambda$ (b) $2\cos\alpha=2n\lambda t/\mu$
(c) $\cos\alpha=2n\lambda/\mu t$ (d) $\cos\alpha=2n\lambda+\mu t$

405. White light is incident on two parallel glass plates separated by an air film 0.001 cms in thickness, the number of dark bands seen in the spectrum between wave length $4\mathrm{x}10^{-6}$ and $7\times10^{-}5$ cms is

(a) 25 (b) 30
(b) 20 (d) 18.6

406. Soap film exhibits brilliant colours in sun light due to

(a) Dispersion of light (b) Scattering of light
(c) Interference of light (d) Diffraction of light

407. A monochromatic light beam when passed through prism is

(a) deviated (b) diffracted
(c) dispersed (d) polarized

408. In Newton's rings experiment the radius of the nth dark ring for air is

(a) $\sqrt{n\lambda R}$ (b) $n\lambda R$
(c) $n\lambda R/\mu$ (d) $\lambda R/\mu n$

409. The air space between the lens and glass plate is raplaced with water in Newton's ring experiment. The ring pattern

(a) contracts (b) expands
(c) remains the same

410. Centre of the system of rings will be dark provided

(a) the lens is a small distance away from the glass plate
(b) the surfaces of the glass plate and the lens are in contact at the centre
(c) water is introduced in the gap between lens and glass plate
(d) none of the above

411. In order to obtain a white centre in the newton's ring experiment we should

(a) place the lens a small distance above the glass plate
(b) place the lens in contact with the glass plate
(c) introduce distilled water in the gap between flint glass lens and crown glass plate
(d) a small quantity of oil of Sassafras is placed between lens of crown glass and a plate of flint glass

412. The diameter of tenth dark ring in a Newton's ring experiment system viewed normally by reflected light of $\lambda=6\times10^{-5}$cms, is 0.60 cms. The radius of the lens is

(a) 155 cms (b) 156 cms
(c) 150 cms (d) 145 cms

413. In phosphorescence
   (a) the substance once exposed to ultra violet light continues to emit light even when the incident light is removed
   (b) the substance absorbs radiation of shorter wavelength and re-emit radiation of longer wavelength
   (c) the substance stops radiation once the light is removed
   (d) none of the avove

414. Appearence of sky is blue because
   (a) blue light has greater velocity than that of other colour
   (b) blue coloured light has greater intensity than that of other colour
   (c) blue coloured light is absorbed the least in the atmosphere
   (d) the light of blue colour is scattered the least in the atmosphere

415. The fringes in the Newton's ring experiment are called
   (a) Fringes of equal inclination
   (b) Fringes of equal thickness
   (c) Faidingh fringes
   (d) Localised fringes

416. Dispersive power of grating is increasing with
   (a) order of the spectrum
   (b) number of lines per cms
   (c) order and the number of lines per cms
   (d) total number of lines of the seating

417. Resolving power of a prism for a pair of spectral lines depends completely on
   (a) thickness of the base of the prism
   (b) material of the prism
   (c) thickness and material of the prism
   (d) angle of the prism

418. A Polaroid is
   (a) a light filter
   (b) an adjustable shutter
   (c) a device for analysing polarised light
   (d) a device used in polarimeter

419. In a plane polarised light there is

(a) vibration in all direction
(b) vibration in two mutually perpendicular direction
(c) no vibration
(d) vibrations are along one straight line perpendicular to the direction of propagation

420. Light produced by a single Nicol is

(a) unpolarised (b) plane polarised
(c) circularly polarised (d) elliptically polarised

421. The spectrum of the light from the Sun is found to be crossed by a large number of fine dark lines, called

(a) Fresnel lines (b) Resonance levels
(c) Fraunhofer lines (d) W. Herschel's lines

422. When a plane polarised light passes through a quarter wave plate, we get circularly polarised light when the angle between the plane polarised and the principle axis of the plate is

(a) 0 degrees (b) 90 degrees
(c) 45 degrees (d) 270 degrees

423. The thickness of a quarter wave plate, if μ_o is the refractive index of the crystal for the ordinary rays and μ_e that for the extra ordinary ray, is given by the formula

(a) $t=n\lambda/2(\mu_o+\mu_e)$ (b) $t=n\lambda/(\mu_o-\mu_e)\times 2$
(c) $t=n\lambda/2\mu_o\mu_e$ (d) $t=2n\lambda/\mu_o\mu_e$

424. The Zeeman effect is observed when

(a) a beam of light passes through powerful magnetic field only
(b) a source of light is placed in a magnetic field
(c) a magnetic field is excluded from a light source
(d) only white light is used

425. Raman effect is due to

(a) coherent scattering (b) incoherent scattering
(c) no scattering (d) refraction

426. In order to measure the distance between two coherent sources in the Bi-prism experiment, the convex lens should be placed,

(a) between the source and the slit
(b) between the slit and the Bi-prism
(c) between the Bi-prism and the eye piece

427. The phenomenon of flourescence differs from the Raman scattering in one of the following ways
    (a) intensity of the Raman lines is of the same order as that of the flourescent lines
    (b) the reradiated energy, in the case of fluorescence is of a frequency other than the one which the fluorescing substance is able to absorb
    (c) the intensity of the Raman lines is of an entirely different order than that of fluorescent lines

428. To resolve stars seprated by 1 second of arc for $\lambda = 6 \times 10^{-5}$ cm, the aperature size of the objective of a telescope is given by
    (a) a=10 cms   (b) a=12 cms
    (c) a= 9 cms   (d) a=15 cms

429. Discrete emission spectrum is given by
    (a) Candle
    (b) Sun
    (c) incandesent filament lamp
    (d) Mercury vapour lamp

430. Diffraction effect is
    (a) more for a round edge
    (b) less for a round edge
    (c) more for a sharp edge
    (d) irrespective of the nature of the edge

431. Interference of light waves results in alternate areas of minimum and maximum intensity means that
    (a) Energy at the dark spots has been destroyed
    (b) Energy at the bright spots has been created
    (c) There is transfer of energy from dark to bright region
    (d) Average energy of the medium is reduced

432. Which one is not a condition for permanent interference of light
    (a) Two sources should continuously emit waves of the same wave-length
    (b) Amplitudes of the two wave trains should be equal
    (c) The two sources should be very narrow
    (d) Interfering wave fronts must interfere at an angle of 45°

433. Which of the following is not an example of interference by division of wave front

(a) Newton's rings (b) Young's slits
(c) Fresnel Bi-prism (d) Lloyd's Mirror

434. Point out the incorrect statement with reference to interference

(a) $x = Dn\lambda/d$ gives the condition for a bright fringe

(b) $x = \frac{D(2n-1)\lambda}{2d}$ gives the condition for a dark fringe

(c) The distance between two successive dark or bright fringes is same

(d) $\beta = \frac{D}{d}\frac{\lambda}{2}$ gives the fringe width of bright fringes

535. Green light of wave length 5100 A° from a narrow slit is incident on a double slit. If the over all seperation of 10 fringes on a screen 300 cm away is 3 cm, the double split separation is

(a) 0.051 mm (b) 0.51 mm
(c) 5.1 mm (d) 5.1 cm

436. What is the fringe width of interference pattern formed by two narrow slits 0.3 mm apart, if the wave-length of the light used is 5100 A° and screen is at a distance of 30 cms

(a) 0.051 cm (b) 0.51 cm
(c) 5.1 mm (d) 5.1 cm

437. In Fresnel's double mirror experiment, the interfering light

(a) comes from two real sources of light placed very close
(b) comes after reflection from the back surface of the mirror
(c) comes after reflection from the front surface of the mirror
(d) none of the above

438. In a young's interference experiment, if a thin glass plate is placed in the path of one of the interfering beams, then

(a) Fringe width increases
(b) Fringe width decreases
(c) Fringe pattern gets shifted
(d) Fringe pattern is unaffected

439. A thin film of plastic of refractive index 1.51 for light of wavelength 5100°A is inserted normally in the path of one of the interfering beams. The Central Bright band shifts through 10 fringes. Therefore, the thickness of the film is

(a) 10^{-4} cms (b) 10^{-3}
(c) 10^{-2} cm (d) 10^{-5} cm

440. A slit illuminated by light of wave-length 5100° A is held 3mm from the plane of a mirror. What is the fringe-width of the bands formed on a screen, 300 cm from the slit

(a) 0.255 cm (b) 0.0255 cm
(c) 2.5 cm (d) none of the above

441. Which of the following colour phenomenon is not an interference phenomenon

(a) Oil spread on the surface of water exposed to extended source of light exhibits brilliant colours
(b) soap bubbles in sunlight show colours
(c) sky seems blue at noon but red at evening and dawn
(d) metallic surface when heated displays colours

442. In a thin film interference system

(a) the reflected system and the transmitted system are same
(b) the reflected system and transmitted system are opposite
(c) none of the above

443. A parallel beam of sodium light ($\lambda = 5890 \times 10^{-8}$ cm) is incident on a thin plate of $\mu = 1.5$ such that the angle of reflection into the plate is 60°. What is the smallest thickness of the plate which will make it appear bright by transmission.

(a) 3927×10^{-8} cm (b) 3.927×10^{-8} cm
(c) 4×10^{-8} cm (d) 392.7×10^{-8} cm

444. In moving the mirror M_1 of Michelson's interferometer through a distance of 0.5 mm, 1500 fringes are counted. The wave-length of the light is therefore,

(a) 66 A° (b) 666 A°
(c) 6666 A° (d) none of the above

445. One of the tubes of Jamin's interferometer contains air at room temperature and atmospheric pressure, while the removal of air from the other corresponds to a shift of 150 fringes. If the wave length of light be 5×10^{-5} cms and the tubes are 25 cms long, the refractive index of air is

(a) 1.003 (b) 1.0003
(c) 100.3 (d) 0.10003

446. Two close lines in a spectrum are said to be just resolved when

(a) central maximum of the diffraction pattern of one falls upon the first maximum of the diffraction pattern of the other

(b) central maximum of the diffraction pattern of the one falls upon the first minimum of the diffraction pattern of the other

(c) central minimum of the diffraction pattern of the one falls upon the first maximum of the diffraction pattern of the other

447. Resolving power of a telescope is given by

(a) λ/D (b) $1.22\ D/\lambda$
(c) $1.22\ \lambda/D$ (d) $\lambda/1.22\ D$

448. The resolving power of a telescope whose object lens has a diameter of 180 cms for a light of 6×10^5 cms wavelength is

(a) 4.6×10^{-7} rad (b) 4.6×10^{-9} rad
(c) 4.6×10^{-8} rad (d) 4.6×10^{-6} rad

449. Resolving power of a microscope is given by

(a) $1.22\lambda/2 \sin\theta$ (b) $\lambda/2 \sin\theta$
(c) $1.22\lambda/\sin\theta$ (d) $2\lambda/1.22 \sin\theta$

450. Which is incorrect with reference to polarisation by reflection

(a) the degree of polarisation varies with the angle of incidence

(b) percentage of the polarising light in the reflected beam is greatest at the angle of polarisation

(c) reflected light is plane polarised in the plane of incidence

(d) reflected light is plane polarised in the plane perpendicular to incident plane.

451. Brewster's Law is given by

(a) $\mu = \text{Cos } i$ (b) $\mu = \text{Cot } i$
(c) $\mu = \text{Sec } i$ (d) $\mu = \tan i$

452. A ray of light is incident on the surface of glass plate of refractive index 1.0 at the polarising angle. What is angle of refraction

(a) 40° (b) 45°
(c) 60° (d) 75°

453. If a ray of light is allowed to pass through a quartz crystal, then the two refracted rays obtained are

(a) plane polarised and planes of polarisation are parallel
(b) circularly polarise in opposite directions
(c) plane polarised and planes of polarisation are perpendicular
(d) circularly polarised in same direction

454. Law of Malus states that
(a) when a ray of light passes through a quartz crystal it is split into two beams.
(b) there is an angle of polarisation for all reflected polarisation
(c) the intensity of incident polarised ray is equal to the sum of the intensities of the two refracted rays.
(d) the two refracted rays are plane polarised and their planes of polarisation are perpendicular.

455. Calculate the thickness of a quarter wave plate for light of wave length 5100A° the refractive indices for ordinary and extra ordinary rays being 1.55 and 1.56 respectively.
(a) 0.0025 cm (b) 0.00128 cm
(c) 0.0128 cm (d) 0.00025 cm

456. Specific rotation is given by
(a) $S=\theta\times l/d$ (b) $S=\theta/(l\times d)$
(c) $S=\theta^2/(l\times d)$ (d) $S=\theta/(2\times l\times d)$

457. Primary focal length of a zone plate is given by
(a) $f=r_n^2/n\times\lambda$ (b) $f=r_n/n\times\lambda$
(c) $f=r_n/n\times\lambda^2$ (d) $f=1.22\ r_n/n\times\lambda$

458. For a wave length of light $=5\times10^{-5}$ cm and radius of the first half period zone $=0.5$ mm a zone plate brings rays to focus at its brightest spot. The focal length of the equivalent lens is
(a) 500 cm (b) 5 cm
(c) 50 cm (d) 5 mm

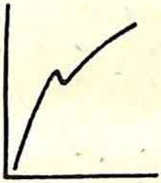
459. In a zone plate and a convex lens
(a) both produce real image of an object on the side other than the object
(b) both produce virtual image of an object on the side other than the object.
(c) Zone plate produce a virtual image and convex lens a real image on the side other than the object.
(d) none of the above.

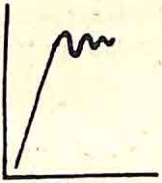
460. Comparing a zone plate and convex lens it is observed that
    - (a) zone plate shows spherical aberration while the lens does not
    - (b) zone plate shows chromatic aberration while the lens does not
    - (c) zone plate and lens both show chromatic aberration.
    - (d) zone plate and lens both show spherical aberration

461. Point out the wrong statement
    - (a) the intensity of image in a zone plate decreases as the order of the focal length increases.
    - (b) zone plate and convex lens produce virtual image on the side other than the object.
    - (c) in a zone plate red focus is nearer than violet.
    - (d) a convex lens has one focus while a zone plate many.

462. Fresnel diffraction is
    - (a) a near field phenomenon.
    - (b) a far field phenomenon.
    - (c) none of the above

463. Diffraction pattern of a straight edge is given by


a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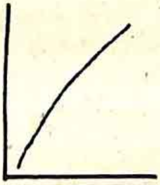
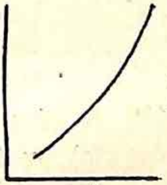

c


d

464. Tick the wrong statement
    - (a) Interference is due to interaction of light waves resulting from the division of a wave point into two parts primarily originating from the same source.
    - (b) Diffraction is due to interaction of light waves from different parts of the same wave point
    - (c) Interference bands and diffraction bands are equally spaced.
    - (d) Diffraction bands are of varying spacing.

465. A circular aperture of 0.5 mm radius is illuminated by plane waves of monochromatic light. The diffracted light received on a screen which is gradually moved towards the

aperture. If the centre of the circular path of light first becomes dark when the screen is 25 cm from the aperture find the wave length used.

(a) 2×10^{-5} cm (b) 1×10^{-5} cm
(c) 4×10^{-5} cm (d) 1.25×10^{-5} cm

466. An astronomer was viewing a distant star with a Michelson's interferometer, what is the angular diameter of the star if $\lambda=5.1\times10^{-5}$ cm is the average wave-length from the star and D=510 cm, the seperation between the two mirrors in the interferometer.

(a) 1.22×10^{-8} rad (b) 6.1×10^{-8} rad
(c) 6.1×10^{-5} rad (d) 12.2×10^{-8} rad

467. What is the radius of the first dark ring of the diffraction pattern formed by a lens of 5 cms focal length, if $\lambda=5100$A° and diameter of the aperture = 1.22 cm

(a) 2550×10^{-7} cm (b) 2550×10^{-8} cm
(c) 5000×10^{-8} cm (d) 2550×10^{-6} cm

468. In a plane transmission grating

(a) light diffracts to produce the resultant pattern
(b) light interfers to produce the resultant pattern
(c) light polarises to produce the resultant pattern
(d) light diffracts and interfers to produce the resultant pattern

469. Grating law states that

(a) each slit in grating sends out a diffracted beam only
(b) each slit in grating sends out a diffracted beam that interfers later to produce the pattern
(c) each slit in grating sends out an interfered beam only
(d) $(a+b)= \pm n\lambda/\sin\theta$ for the first order principal maxima

470. If one looks at the filament of an incandescent lamp at a distance, through a fine silken handkerchief, a central white filament with several coloured filaments on the side is seen. This is an example of

(a) Thin film interference
(b) Thick film interference
(c) Rotatory polarisation
(d) Diffraction

471. Dispersive power of a grating is given by

(a) $\frac{d\,\theta}{d\,\lambda}=\frac{m\,\lambda}{\text{Sin}\,\theta}$ (b) $\frac{d\,\theta}{d\,\lambda}=\frac{n.m}{\text{Cos}\,\theta}$

(c) $\frac{d\,\theta}{d\,\lambda}=\frac{n.m}{\text{Tan}\,\theta}$ (d) $\frac{d\,\theta}{d\,\lambda}=\frac{m}{\lambda\,\text{Sin}\,\theta}$

472. Tick the wrong statement for a diffraction grating

(a) The spectrum formed by a grating is pure i.e., there is no overlapping or mixture of colours

(b) The spectrum formed by one grating is exactly similar to that formed by another grating

(c) In grating dispersion depends upon the wave-length only

(d) none of the above

473. A parallel beam of monochromatic light is allowed to be incident normally on a plane transmission grating having 2500 lines/cm and the second order spectral line is found to be diffracted through 30°. The wave-length of the light used is thus

(a) 10^{-4} cm (b) 10^{-5} cm
(c) 10^{-3} cm (d) 10^{-6} cm

474. What is the angle between the central image of a lamp filament and its first diffracted image produced by a silken handkerchief of 150 threads per cm ($\lambda=6\times10^{-5}$ cm)

(a) $\theta=\text{Sin}^{-1}\,0.009$ (b) $\theta=\text{Sin}^{-1}\,0.09$
(c) $\theta=\text{Sin}^{-1}\,1$ (d) none of the above

475. The number of lines needed on a grating to just resolve 4000 and 4001 A° in the first order spectrum is

(a) 4000 (b) 8000
(c) 2000 (d) 400

476. Which of the following is the points of difference between the prism and grating spectra

(a) A grating gives a number of spectra on either side of the central maximum while a prism gives only one spectrum

(b) A grating spectrum is pure while a prism spectrum is impure

(c) In a grating spectra deviation is proportional to the wave-length of the light used, where as in a prism it decreases with increasing wave-length

(d) All of the above

477. What is the power in dioptres of a lens of 25 cm focal length

(a) 25	(b) 4
(c) 40	(d) 52

478. The distance between the object and its real image in a convex lens of focal length 50 cm is

(a) 100 cm	(b) 250 cm
(c) 200 cm	(d) 150 cm

479. If 5 cm is the distance of the object from the focus and 5 cm is the distancc of the image from the focus of a mirror, then the focal length of the mirror is

(a) 5 cm	(b) 25 cm
(c) 20 cm	(d) 10 cm

4

ELECTRICITY AND MAGNETISM

480. Which of the following substances can be used as a base for making magnet:

(a) soft iron	(b) manganese steel
(c) both a & b	(d) copper

481. For an electromagnet

(a) the retentivity of the material should be large.
(b) the susceptibility of the material should be small.
(c) the retentivity small and susceptibility large
(d) none of the above

482. Which one of the following statements doesn't fall under the Weber's theory of magnetism.

(a) The molecules of a magnetic substance whether magnetised or not, are themselves complete magnets

(b) In an unmagnetised iron piece, the molecules are arranged in groups, each group forming a stable magnetic system

(c) When all the molecular magnets have been aligned, it produces preponderence of north poles at one end south poles at the other

(d) Molecular groups of stable magnetic systems produce the external magnetic field

483. Which of the following facts doesn't support the Molecular Theory.

(a) If a magnet is broken into two pieces, each broken piece behaves like a small magnet

(b) Strong and powerful magnets are made of laminated strips

(c) During magnetisation, a wooden mallet is used to strike the bar which loosens the molecules and they align readily

(d) A bar of iron becomes slighly shorter on magnetisation and this is called magnetostriction

484. According to modern theory of magnetism

(a) most important cause of magnetisation is the spin of the electron

(b) most important cause of magnetisation is the orbital motion of electrons.

(c) heat is produced when a bar is rapidly magnetised or demagnetised

485. Tick the incorrect statement:

(a) Line of force is an imaginary curve.

(b) A compass needle sets itself perpendicular to the line of force

(c) The lines of force originate at the N. Pole and end at the S. Pole

(d) There is always a lateral repulsion between adjacent lines of force

486. Magnetic moment of a magnet is a

(a) scalar quantity (b) vector quantity

(c) don't know

487. Field due to a magnet in the broad-side-on position is given by

(a) $\frac{1}{4\pi\mu_0} \cdot \frac{M}{d^3}$ (b) $\frac{1}{4\pi\mu_0} \cdot \frac{2M}{d^3}$

(c) $M^2/4\pi\mu_0 d^3$ (d) $M^3/4\pi\mu_0 d^3$

488. Tangent law is defined by

(a) $\cot \theta = F/H$ (b) $\tan \theta = F/H$

(c) $\tan \theta = F^2/H^2$ (d) $\cot \theta = F^2/H^2$

489. Deflection magnetometer is used for

(a) comparing the two magnetic field strength

(b) comparing the magnetic moments of two magnets

(c) verifying the inverse square law

(d) all of the above

490. Potential due to a magnetic dipole on the endside position is given by

(a) $\frac{1}{4\pi\mu_0}\left[\frac{M\cos\theta}{d^2}\right]$ (b) $\frac{1}{4\pi\mu_0}\left[\frac{M}{d^2}\right]$

(c) $\frac{1}{4\pi\mu_0}\left[\frac{M\cos\theta}{d^3}\right]$

491. Which of the following line you won't find on a magnetic map

(a) Isobars (b) Isogonics
(c) Isoclinics (d) Isodynamics

492. A ship is made of iron and steel and thus attracts magnetic mines planted by the enemy. How does a minesweeper ship protects itself from the mines

(a) It is made of wood only
(b) It is made of copper only
(c) It has to be degaussed
(d) none of the above

493. If a glass rod is rubbed with a silken handkerchief, then

(a) glass rod acquires negative charge while silk positive
(b) glass rod acquires positive charge while silk negative
(c) glass rod and silk both acquire positive charge
(d) glass rod and silk both acquire negative charge

494. The distance 'r' between the electron and proton in a hydrogen atom is about 5.3×10^{-11} meter, the magnitude of the electrical force is then

(a) $\frac{9.0\times10^{9}\times1.6\times10^{-19}}{5.3\times10^{-11}}$ nt

(b) $\frac{18\times10^{9}\times1.6\times19^{-19}}{5.3\times10^{-11}}$nt

(c) $\frac{9.0\times10^{9}\times1.6\times10^{-19}}{(5.3\times10^{-11})^2}$ nt

495. Tick the wrong statement in relation to an electric field

(a) the tangent to a line of force gives the direction of E-field
(b) the tangent to a line of force also gives the magnitude of the E-field
(c) the lines of force per unit cross-sectional area of field gives the magnitude of the E-field
(d) the electric field is a conservative field

496. The electric field due to an electric dipole is given by

(a) $E=p/4\pi\epsilon_0 r^2$
(b) $E=p.e/4\pi\epsilon_0 r^2$
(c) $E=p/4\pi\epsilon_0 r^3$

497. A charge $q_1(+1.0\times10^{-6}$ coul) is at a distance of 10 cm. from a charge $q_2(+2.0\times10^{-6}$ coul). At what point on the line joining the two charges is the electric field strength zero?

(a) 5 cm.
(b) 4.1 cm.
(c) 10 cm.
(d) zero cm.

498. E-field due to an annualar ring of charge 'q' and radius 'a', at a distance of 'x' from its centre point is given by

(a) $E=q/4\pi\epsilon_0 x^3$
(b) $E=q/4\pi\epsilon_0 x^2$
(c) $E=q^2/4\pi\epsilon_0 x^2$
(d) $E=q^2/4\pi\epsilon_0 x^3$

499. A positive point test charge is placed halfway between two equal point charges, then

(a) the test charge will be sqeezed out
(b) the test charge will be in equilibrium
(c) the test charge will oscillate

500. Two point charges of unknown magnitude and sign are a distance 'd' apart. The electric field strength is zero at one point between them. This means that

(a) both the charges are of same nature
(b) both the charges are of opposite nature
(c) don't know

501. Guass's law is given by

(a) $\epsilon_0\oint\bar{E}.d\bar{s}=0$
(b) $\epsilon_0\oint\bar{E}.d\bar{s}=q$
(c) $\epsilon_0^2\oint\bar{E}.d\bar{s}=q$
(d) $\oint\bar{E}.d\bar{s}=q^2/\epsilon_0$

502. The E-field at a distance 'r' from an infinite line of charge of 'λ' linear charge density is given by

(a) $E=\lambda/4\pi\epsilon_0 r$
(b) $E=\lambda/4\pi\epsilon_0 r^2$
(c) $E=\lambda/2\pi\epsilon_0 r^2$
(d) $E=\lambda/2\pi\epsilon_0 r$

503. A point charge is placed at the center of a spherical Guassian surface. In which of the following cases will the value of ϕ_E, the flux, change

(a) if the surface is replaced by a cube of the same value
(b) if the sphere is replaced by a cube of one-tenth the value
(c) if the charge is moved off-center in the original sphere
(d) if the charge is moved just outside the original sphere

504. A surface encloses an electric dipole, then ϕ_E fort his surface is

(a) infinity (b) q^2
(c) zero (d) don't know

505. A test charge q_0 is moved without acceleration from a point 'A' to a point 'B' against the field. The potential difference is then given by (if 'd' is the distance between A & B),

(a) $Ed/\sqrt{2}$ (b) $Ed/2$
(c) Ed

506. What is the potential due to a point charge 'q' at a distance 'r' from it

(a) $V=q/4\pi\epsilon_0 r$ (b) $V=q/4\pi\epsilon_0 r^2$
(c) $V=q/2\pi\epsilon_0 r$ (d) $V=q/2\pi\epsilon_0 r^2$

507. What must the magnitude of an isolated positive point charge be for the electric potential at 10cm. from the charge to be 100V.

(a) $400\pi\epsilon_0$ coul. (b) $40\pi\epsilon_0$ coul.
(c) $4\pi\epsilon_0$ coul.

508. What is the potential at a distance 'r' from an electric quadrupole of 'Q' quadrupole moment

(a) $V=Q/4\pi\epsilon_0 r^2$ (b) $V=Q/4\pi\epsilon_0 r^4$
(c) $V=Q/4\pi\epsilon_0 r^3$

509. Are we free to call the potential of earth as 100 volt.

(a) yes (b) no
(c) don't know

510. The capacitance of an isolated sphere of radius 'R' is given by

(a) $4\pi\epsilon_0 R^2$ Coul. (b) $16\pi\epsilon_0 R^2$ Coul.
(c) $4\pi\epsilon_0 R$ Coul.

511. The parallel plates of air-filled capacitor are everywhere 1mm apart. What must be the plate area if the capacitance is to be 1 F.

(a) 1.1×10^{8} metre^2 (b) 1.1×10^{-8} metre^2
(c) 1.1×10^{9} metre^2 (d) 1.1×10^{-9} metre^2

512. What is the capacitance of a coaxial capacitor with 'a' & 'b' as radii of inner and outer conductors resp. and length 'l'

(a) $C=2\pi\epsilon_0 l^2/\ln b/a$ (b) $C=2\pi\epsilon_0 l/\ln b/a$
(c) $C=2\pi\epsilon_0 l/(\ln b/a)^2$ (d) $C=2\pi\epsilon_0 l^2/(\ln b/a)^2$

513. If a dielectric is placed between the plates of capacitor
   - (a) its capacitance decreases
   - (b) its capacitance increases
   - (c) its capacitance is unaffected
   - (d) none of the above

514. Tick the false statement:
   - (a) In a dielectric, because the molecules are in constant thermal agitation, the degree of alignment is not complete and increases with increasing field strength
   - (b) If a dielectric is placed in an electric field, induced surface charges appear which tend to weaken the original field within the dielectric.
   - (c) A dielectric body in a uniform electric field will not experience any net force
   - (d) Dielectrics are often replaced by air as dielectric in capacitors to permit higher breakdown voltages

515. Tick the false statement with respect to the three electric vectors.
   - (a) Tangential component of electric field strength is continuous
   - (b) Normal component of electric displacement is continuous
   - (c) Polarisation vanishes in vacuum
   - (d) Polarisation vector is continuous across vacuum boundary

516. Energy stored in an electric field is given by

   (a) $CV^3/2$ (b) $VC^2/2$
   (c) $CV^2/2$ (d) $C^2V^2/2$

517. Will a capacitor store more energy with a dielectric other than air?

   (a) Yes (b) No
   (c) don't know.

518. A parallel plate air capacitor has a capacitance of 100pf. What is the stored energy if the potential difference between the plates is 50 volt.

   (a) 25×10^{-8} Joules (b) 12.5×10^{-8} Joules
   (c) 12.5×10^{-12} Joules (d) 12.5×10^{-9} Joules

519. Resistance of an electrical conductor is given by

   (a) $R=I/V$ (b) $R=\rho.l/A$
   (c) $R=E/J$

520. A rectangular carbon block has dimensions 1.0cm × 1.0cm × 50cm. The resistivity of carbon at 20°C is 3.5×10^{-4} ohm m. Therefore the resistancc measured between the two square ends is

(a) 7.0×10^{-5} ohm (b) 0.18 ohm
(c) 1.8 ohm (d) 7.0×10^{-4} ohm

521. When an electric field is applied to a metal, the electrons modify their random motion in such a way that

(a) they drift slowly along the direction of the field
(b) they drift slowly opposite to the field direction
(c) the net charge transfer across any cross-section is zero

522. What will be the power consumed by a 25 ohm wire if it were put across a mains of 250 volts

(a) 2.5 kw (b) 25 kw
(c) 2.5 w (d) 25 w

523. Heat is developed fastest in a wire

(a) of small thickness
(b) of large thickness
(c) it is irrespective of the thickness of the wire
(d) none of the above

524. Three resistances of 500 ohm, 5000 ohm, and 50 ohm are connected in series across a 555 volt mains, what is the current flowing through them

(a) 1 A (b) 100 mA
(c) 10 mA (d) 10 A

525. What will be the current flowing in a parallel circuit of resistances 100 ohm and 150 ohm if they are connectcd across a mains of 300 volts

(a) 2 A (b) 4.5 A
(c) 45 mA (d) 200 mA

526. If two capacitances of 100 μf and 150 μf are connected in parallel, what will be their total capacitance

(a) 60 μf (b) 250 μf
(c) 15 mf (d) none of the above

527. An ammeter is an instrument to measure current and

(a) has a high resistance
(b) has a low resistance
(c) can have any value of resistance

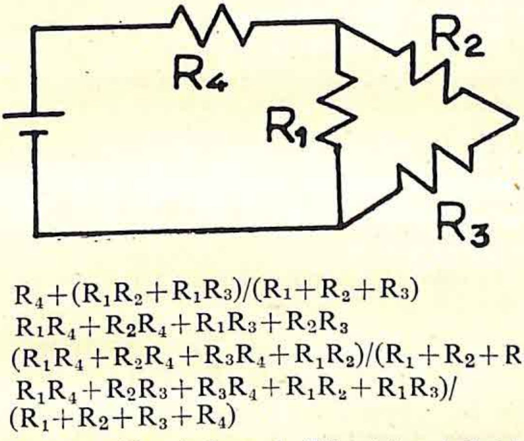
528. A voltmeter is an instrument to measure potential difference and has

(a) a high impedence
(b) a low impedence
(c) an intermediate impedence
(d) none of the above

529. It is possible to generate a 10,000 volt potential difference by rubbing a pocket comb with wool. Why is this large voltage not dangerous when much lower voltage provided by an ordinary electric outlet is very dangerous?

(a) A comb gets only static electricity
(b) Electric outlets supply dangerous alternating currents
(c) Electric outlets supply dangerous direct currents
(d) Electric outlets supply much larger quantity of current

530. What is the equivalent resistance of the circuit shown



(a) $R_4+(R_1R_2+R_1R_3)/(R_1+R_2+R_3)$
(b) $R_1R_4+R_2R_4+R_1R_3+R_2R_3$
(c) $(R_1R_4+R_2R_4+R_3R_4+R_1R_2)/(R_1+R_2+R_3)$
(d) $R_1R_4+R_2R_3+R_3R_4+R_1R_2+R_1R_3)/$
$(R_1+R_2+R_3+R_4)$

531. Three arms of a balanced Wheatstone's bridge are of 75 ohms resistance each. What is the resistance of the fourth arm?

(a) 225 ohm (b) 150 ohm
(c) 75 ohm (d) 300 ohm

532. If a moving electron is deflected sideways in passing through a certain region of space, can we be sure that a magnetic field exists in that space?

(a) Yes (b) No
(c) don't know

533. What is the expression for $\overline{B}$ field at a distance $r<R$ from the center of a long cylindrical wire of radius 'R'. The wire carries a current I.

(a) $B=\mu_0 I r^2/2\pi R^2$ (b) $B=\mu_0 I r/2\pi R^2$
(c) $B=\mu_0 I R/r^2$ (d) $B=\mu_0 I R^2/2\pi r^2$

534. Two like poles repel each other. What will happen to two parallel wires carrying current in the same direction?

(a) They repel each other
(b) They attract each other
(c) they remain unaffected by each other's presence or absence

535. What is the $\overline{B}$-field at the interior points of a toroid of radius 'r' and having 'N' number of turns carrying a current of I_0 amp.

(a) $B=\mu_0 I_0 N/2\pi r$ (b) $B=\mu_0 I_0 N/2\pi r^2$
(c) $B=\mu_0 I_0^2 N/2\pi r^2$ (d) $B=\mu_0 I_0 N/4\pi r$

536. Two conducting loops of different sizes face each other a distance 'd' apart. An observer sights along their common axis. If a clockwise current I is suddenly established in the larger loop, what is the direction of current in the smaller loop?

(a) clockwise.
(b) anti-clockwise.
(c) current will not flow in the smaller loop.
(d) none of the above.

537. Which of the following is not a statement of Faraday's Law?

(a) $E=-d\phi/dt$ (b) $E=-d(N\phi)/dt$
(c) $E=-N\triangle\phi/\triangle t$ (d) $E=-N\triangle t/\triangle\phi$

538. What is the inductance of a toroid of 'b' outer diameter and 'a' inner diameter, 'r' radius, and 'N' turns of 'I' current carrying windings, if it is made up of an iron piece of thickness 'h'?

(a) $L=(\mu_0 N^3 h \ln b/a)/2\pi$
(b) $L=(\mu_0 N^2 h \ln b/a)/2\pi$
(c) $L=(\mu_0 N^2 h \ln b/a)/2\pi$
(d) $L=(\mu_0 N^2 \ln b/a)/2\pi$

539. Inductive time constant is given by

(a) LR (b) R/L
(c) L/R (d) 1/RL

540. Capacitive time constant is given by

(a) RC (b) R/C
(c) C/R (d) 1/RC

541. Time constant of an inductive circuit is that time during which the current in the circuit will reach within......of its final value.

(a) 33% (b) 39%
(c) 37% (d) 60%

542. A solenoid has an inductance of 30 H and a resistance of 30 ohm. If it is connected to a 100 volt battery, how long will it take for the current to reach one-half of its equilibrium value?

(a) 6.9 sec. (b) 69 sec.
(c) 69 msec. (d) 0.69 sec.

543. The energy stored in a magnetic field is given by

(a) $q^2/2c$ (b) $LI^2/2$
(c) $L^2I/2$ (d) LI^2

544. A coil has an inductance of 5.0 H and a resistance of 20 ohm. If a 100 V emf is applied, what energy is stored in the magnetic field after the current has build up to the maximum value?

(a) 63 Joules (b) 6.3 Joules
(c) 3.6 Joules (d) 50 Joules

545. The magnetic energy stored in a coaxial cable of length 'l' and 'a' & 'b' inner and outer conductor radii respectively, is given by

(a) $\frac{\mu_0 l}{4\pi} \ln b/a$ (b) $\frac{\mu_0 l}{4\pi} \ln a/b$

(c) $\frac{\mu_0 i^2 l}{4\pi} \ln b/a$ (d) $\frac{\mu_0 i^2 l}{4\pi} \ln a/b$

546. Two coils are connected in series. Their equivalent inductance is

(a) dependent upon their geometrical relationship to each other
(b) independent of their geometrical relationship
(c) less than the individual inductance.
(d) none of the above

547. Does the time required for the current in a particular LR circuit to build upto any given fraction of its equlibrium value depend upon the value of the applied emf?

(a) No (b) Yes
(c) don't know

548. Curie's Law is given by

(a) $M = CB^2/T^2$ (b) $M = BC^2/T$
(c) $M = BC/T^2$ (d) $M = CB/T$

549. Exchange coupling is particularly important for

(a) diamagnetism (b) ferromagnetism
(c) paramagnetism

550. Tick the incorrect statement

(a) normal component of magnetic induction across a surface is continuous.
(b) tangential component of magnetic field is continuous.
(c) magnetisation vanishes in vacuum.
(d) magnetisation vector is continuous across vacuum boundary.

551. Two iron bars always attract, no matter the combination in which their ends are brought near each other. It means that

(a) both the bars are magnetised in the same direction
(b) only one of the bars is magnetised
(c) one bar is of paramagnetic substance
(d) one bar is of diamagnetic substance

552. The earth is huge magnetic dipole. Its north pole lies towards

(a) the geographical north
(b) the geographical south
(c) don't know

553. What is the angular frequency of an LC circuit of $L = 10$ mh & $C = 1.0\ \mu f$

(a) 1.0×10^5 rad/sec. (b) 1.0×10^4 rad/sec.
(c) 10×10^3 rad/sec. (d) 1.0×10^6 rad/sec.

554. In a guard-ring condenser the purpose of the guard-ring is

(a) to increase the capacity
(b) to decrease the capacity
(c) to avoid the variation of intensity at the edges
(d) to increase the effective area of the capacitor plates.

555. To move a unit charge (positive), from one point to another on an equipotential surface

(a) work is done by the charge
(b) work is done on the charge
(c) no work is done
(d) work done is a constant

556. Three identical capacitors of capacitance 'C' each, are connected in series and, this combination is connected in parallel with one more identical capacitance. The capacitance of the whole combination is

(a) 3C (b) 3/C
(c) 4C/3 (d) 3C/4

557. Two condensers of capacitance 'C' each are connected in series. Their equivalent capacity is

(a) C/2 (b) C
(c) 2C (d) C^2

558. A transformer is used to

(a) convert mechanical energy into electrical energy
(b) convert alternating current into direct current
(b) convert direct current to alternating current
(d) transform alternating current voltage

559. The impedence of an 8 μf condenser at 1000 Hz is

(a) 2200 ohm (b) 20 ohm
(c) 11 ohm (d) 20,000 ohm

560. The fuses are used in electrical power lines to

(a) keep the mains voltage constant
(b) open the line permanently in case of an overload
(c) give an indication of an overload
(d) as a switch to be used in an emergency

561. The phase angle between the voltage and current in AC, through a resistor is

(a) 180° (b) 270°
(c) 45° (d) 0°

562. According to Faraday's Law, the total charge induced in a conductor that is moved in magnetic field depends upon

(a) initial magnetic flux
(b) final magnetic flux
(c) rate of change of magnetic flux
(d) change in magnetic flux

563. In a purely inductive circuit, the current

(a) lags behind the emf by 90°
(b) leads the emf by 90°
(c) is in phase with the emf
(d) may lag or lead the emf

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564. It is possible to do electroplating using
   (a) a D.C. source (b) an A.C. source
   (c) any source of emf

565. Three resistances of 1 ohm each are connected to form a triangle. The resistance between any two terminals is
   (a) 3/2 ohm (b) 2/3 ohm
   (c) 3 ohm (d) 1 ohm

566. Two resistances of 0.275 ohm and 0.778 ohm are connected in parallel. The total resistance shall be
   (a) more than 0.275 ohm
   (b) less than 0.275 ohm
   (c) equal to 1.053 ohm
   (d) more than 0.778 ohm

567. Two incandescent bulbs are lighted in a room. One of them is dim, then it can be infered that
   (a) it has a lesser resistance of the two
   (b) it has more resistance than the other
   (c) both the bulbs have equal resistance
   (d) brightness doesn't depend upon resistance of the bulbs

568. The electric and magnetic lines of force differ in that
   (a) Electric lines of force are closed curves while the magnetic lines of force are not
   (b) Magnetic lines of force are closed curves while electric lines of force are not
   (c) Magnetic lines can give direction of field while electric field lines cannot
   (d) Electric lines of force can give direction of magnetic field while electric field lines cannot.

569. The dynamo
   (a) creates electrical energy
   (b) converts electrical energy into mechanical energy
   (c) converts mechanical energy into electrical energy
   (d) converts magnetic energy into mechanical energy

570. The 'electron-volt' is a unit of
   (a) momentum (b) potential difference
   (c) electronic current (d) energy of the electron

571. Which of the following liquids is used in a Lead accumulator
   (a) caustic soda (b) soda-bicarbonate
   (c) sulphuric acid (d) hydrochloric acid

572. When a transformer for stepping up voltage from 100 V to 200 V is connected across a mains of 50 V direct current, then

(a) the output becomes 100 V
(b) the circuit breaks down due to heavy currents
(c) no voltage is induced in the secondary
(d) the output voltage becomes 200 V

573. An A.C. voltmeter measures V_0 volts in a circuit. Its peak to peak value is

(a) $V_0/\sqrt{2}$ (b) V_0
(c) V_0^2 (d) $\sqrt{2}$ V

574. In a step-down transformer of 2 : 1 turns ratio, a dry cell of 9 V is connected across the primary. The voltage across the secondary is

(a) 4.5 V (b) zero volt
(c) 9 V (d) cannot be said

575. The rms value of emf in a circuit is given by a factor of

(a) 1.11 (b) 0.707
(c) 0.07 (d) 0.637

576. The product of absolute permittivity and absolute permeability of free space is given by

(a) C^2 (b) C
(c) 1/C (d) $1/C^2$

577. Self-inductance of a solenoid is

(a) directly proportional to the current flowing through the coil
(b) directly proportional to its' length
(c) inversely proportional to the area of cross-section
(d) directly proportional to the number of turns

578. In a Copper Voltameter, the amount of Copper deposited on cathode increases as

(a) the current is decreased
(b) area of the electrodes is increased
(c) time for passing the current is increased
(d) area of the electrodes is decreased

579. Which of the following is a correct statement of Ohm's Law.

(a) product of current through a conductor and potential difference across it gives the resistance of the conductor.

(b) the ratio of potential difference across a conductor to the current passing through it is always constant.

(c) all physical conditions remaining constant, the potential difference across a conductor is directly proportional to the current in it.

(d) none of the above

580. Electrometers can be used to measure

(a) alternating voltages
(b) electrostatic potentials
(c) dynamic currents
(d) both 'a' & 'b' above

581. Kelvin's Absolute Electrometer can be used to measure

(a) magnetic permeability
(b) permittivity of a dielectric
(c) alternating voltages
(d) alternating currents

582. In a Heterostatic use of a quadrant electrometer

(a) the needle and one of the quadrants are shorted
(b) the needle and both the quadrants are shorted
(c) the needle is given a very high potential
(d) the needle is grounded and quadrants given the measuring potential

583. In the Idiostatic use of a quadrant electrometer

(a) the needle and one of the quadrants are shorted
(b) the needle and both the quadrants are shorted
(c) the needle is grounded
(d) one of the quadrants is grounded

584. A quadrant electrometer can't be used for one of the following purposes. Tick it.

(a) comparison of potentials
(b) measuring ionising currents
(c) measuring permeability
(d) determining dielectric constant

585. An electrometer is charged by connecting it across a battery momentarily and a deflection of 100 divisions is observed. A condenser of 50 μf is connected in parallel with the electrometer and the deflection falls to 50 divisions. The capacity of the electrometer is therefore

(a) 50 μf (b) 100 μf
(c) 150 μf (d) 2500 μf

586. An electric current doesn't possess one of the following effects:

(a) magnetic effect (b) heating effect
(c) chemical effect (d) gravitational effect

587. Reduction Factor of a Tangent Galvanometer is defined as that current which, when flowing through the Galvanometer, produces

(a) a deflection of 90° (b) a deflection of 270°
(c) a deflection of 45° (d) no deflection at all

588. A Tangent Galvanometer is most sensitive while recording a deflection near about

(a) 60° (b) 45°
(c) 75° (d) 90°

589. Which one of the following is disadvantage of the sine galvanometer over that of a tangent galvanometer

(a) the sine galvanometer is more sensitive
(b) the sine galvanometer has a limited range
(c) the needle in a sine galvanometer moves in a uniform field
(d) torsional error is absent

590. For an area of 25 sq. cm., a loop in a moving coil galvanometer will produce maximum deflection with

(a) square geometry (b) rectangular geometry
(c) circular geometry (d) any geometry

591. Tick the incorrect statement:

(a) the pole faces of a moving coil galvanometer are cut radially
(b) the effect of stray magnetic field in M.C. Galvanometer is negligible
(c) sensitiveness of such a galvanometer can be increased by increasing the no. of turns of the coil
(d) sensitiveness can be increased by reducing the area of the loop

592. Moving Iron Galvanometer can be used for measuring

(a) direct currents only
(b) alternating currents only
(c) both alternating and direct currents
(d) none of the above

593. Figure of merit of a galvanometer is the
    - (a) deflection in mm produced on a scale 1000 mm away when a current of 1 micro-ampere is passed
    - (b) is the current which will produce a deflection of one division
    - (c) deflection in mm produced on a scale 1000 mm away when a potential of 1 micro-volt is connected across it
    - (d) none of the above

594. What fraction of the total current is flowing through a galvanometer of 95 ohm resistance, if a 5 ohm shunt is connected across it
    - (a) 10%
    - (b) 5%
    - (c) 95%
    - (d) very less current will flow

595. A galvanometer gives full scale deflection with 0.2 mA. The resistance of its coil is 1000 ohm. What is the value of the shunt for it to read upto 2 ampere
    - (a) 1 ohm
    - (b) 0.1 ohm
    - (c) 10 ohm
    - (d) 10 m-ohm

596. Which of the following meters would you use to detect a fault in the house-wiring system
    - (a) voltmeter
    - (b) ammeter
    - (c) megger
    - (d) ohm-meter

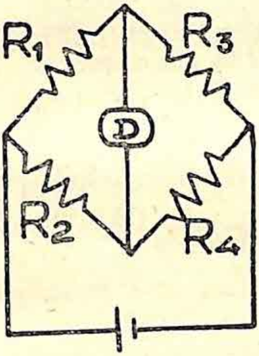
597. What is the current in a circuit of 100 ohm resistance connected in series with two ideal Lechlanche cells af 0.75 V and 0.25 V
    - (a) 0.01 amp
    - (b) 0.0036 amp
    - (c) 0.036 amp
    - (d) 0.1 amp

598. Two dry cells of 9V each are connected in parallel across a resistance of 9 ohm. The current in the circuit is
    - (a) 50 mamp
    - (b) 500 mamp
    - (c) 5 mamp
    - (d) 5 ampere

599. A cell of 5V and internal resistance 1 ohm will give maximum power output to
    - (a) two resistances of 2 ohm each connected in parallel
    - (b) two resistances of 1 ohm each connected in series
    - (c) a single resistance of 2 ohm
    - (d) four resistances of 0.5 ohm connected in series

600. Which one of the following is not a statement of the Kirchoff's Law
    - (a) the algebraic sum of the currents at any junction in a circuit is zero
    - (b) in any closed circuit, algebraic sum of emf's is zero
    - (c) resistance of a conductor is equal to the ratio of voltage and current in that conductor
    - (d) the current going into a junction is equal to the current leaving the junction

601. In the Wheastone's bridge shown in the diagram what is the value of R_4 for a null, if $R_1=5$ ohm, $R_2=10$ ohm, & $R_3=15$ ohm
    - (a) 20 ohm
    - (b) 30 ohm
    - (c) 40 ohm
    - (d) 250 ohm



602. If in the above question, the battery and the galvanometer are interchanged, the value of R_4 will be
    - (a) 20 ohm
    - (b) 30 ohm
    - (c) 40 ohm
    - (d) 250 ohm

603. A potentiometer cannot be used for the measurement of
    - (a) current
    - (b) voltage
    - (c) internal resistance of a cell
    - (d) dielectric constant

604. It is found that 135 cm of a potentiometer wire are required to balance the emf of a cell but that only 100 cm. of the wire is required for the balance if the poles of the cell are joined to a resistance of 3 ohm. The internal resistance of the cell is then

(a) 10 ohm (b) 10.5 ohm
(c) 3 ohm (d) 35 ohm

605. Two resistances 'X' & 'Y' of 15 and 25 ohm respectively are connected across a battery of 5V, first in parallel and then in series. The heat produced is

(a) more in the first case
(b) more in the second case
(c) equal in both the cases

606. The amount of heat developed in a resistor is directly proportional to

(a) the square of the current only
(b) the resistance of the conductor only
(c) the time of current-passage only
(d) the square of the current, resistance and the time of current-flow

607. Electro-chemical-equivalent (ECE) of an ion is the mass of that ion liberated by one ampere of current flowing for

(a) 1 second (b) 1 minute
(c) don't know

608. In electroplating the material to be plated is made the

(a) anode (b) cathode
(c) can be any electrode

609. Neutral temperature of a thermocouple is the temp. at which

(a) the thermo-emf changes sign
(b) the thermo-emf is maximum
(c) the thermo-emf is minimum
(d) the thermo-current is maximum

610. Tick the wrong statement:

(a) temp. of inversion is that temp. at which the thermo-emf reveres sign.
(b) neutral temp. is the temp. at which max. thermo-emf is produced
(c) temp. of inversion depends upon the cold junction temp.
(d) temp. of inversion like neutral temp. is a constant

611. In an Antimony-Bismuth couple, the current flows from

(a) Bismuth to Antimony
(b) Antimony to Bismuth
(c) any one element to the other element

612. When a strong current is passed across a junction from Bismuth to Antimony, the junction gets cooled. It is an example of

(a) Seeback Effect (b) Thomson's Effect
(c) Peltier's Effect (d) Zeeman Effect

613. In Joule's Effect heat is liberated when a current I is passed through a coil. Then which of the following statements is true

(a) Joules effect is reversible but Peltier's effect is irreversible
(b) Joule's effect is irrevesible but Peltier's effect is reversible
(c) both Joule's and Peltier's effects are irreversible
(d) both, Joule's and Peltier's effects are reversible

614. Specific heat of electricity is defined by

(a) Peltier's coefficient (b) Thomson's coefficient
(c) Seeback coefficient (d) none of the above

615. Different parts of a metal when maintained at different temps. exhibit the presence of an emf source. This phenomenon is called

(a) Stark effect (b) Zeeman effect
(c) Peltier's effect (d) Thomson's effect

616. Susceptance of a circuit is the reciprocal of

(a) admittance (b) resistance
(c) reactance (d) impedence

617. Which one of the following is not an advantage of A C over D C

(a) the AC shows skin effect
(b) in AC a wide range of voltages is possible
(c) line losses in AC transmission lines are negligible
(d) in AC the magnitude of current can be reduced by a choke

618. The main advantage of the direct current is that

(a) motors and appliances operating on it are more robust
(b) it can be converted into AC easily
(c) line losses are very less with DC
(d) there are certain processes where AC can't be used at all

619. In a series resonant circuit, the current at resonance is

(a) maximum (b) minimum
(c) zero

620. In a parallel resonant circuit, at resonance

(a) the current is max
(b) the voltage is max
(c) the impedence is minimum
(d) impedence is zero

621. A resistance of 5 ohm is put in series with an inductance of 200 mH and capacitance of 30 pf. If the resonant frequency be 50c/s, what is the current at resonance, for a 100 V emf source

(a) 200m amp
(b) 20 amp
(c) 2 amp
(d) 200 amp

622. The resonant frequency of a circuit is given by

(a) $1/2\pi\sqrt{LC}$
(b) $1/4\pi\sqrt{LC}$
(c) $1/\sqrt{LC}$
(d) $\sqrt{L}/2\pi\sqrt{C}$

623. Rejector circuits are

(a) parallel resonant circuits
(b) series resonant circuits
(c) don't know

624. In an L-C-R circuit

(a) the current lags the impressed voltage
(b) the current leads the impressed voltage
(c) the current may lag, lead or remain in phase with the voltage
(d) the current remains in phase with the voltage

625. In an AC circuit the peak to peak volltage is 5V and a peak to peak current of 5A is flowing. The power consumption is then given by

(a) 5W
(b) 30W
(c) 15W
(d) 10W

626. Which of the following is not a correct statement of Power Factor

(a) p. f.=True watts/apparent watts
(b) p. f.=apparent watts/true watts
(c) p. f.=resistance/impedence

627. The minimum diameter of a conductor carrying current for delivering maximum power-output occurs at a power factor of

(a) 0.5 lag
(b) 0.75 lag
(c) 0.25 lag
(d) 1

628. What is the power factor of a circuit of 50 ohm resistance & 100 ohm impedence
    (a) 0.5 (b) 5
    (c) 0.75 (d(0.25

629. A lagging power factor can be controlled by
    (a) connecting an inductance in parallel with the circuit
    (b) connecting a resistance in parallel to the circuit
    (c) connecting a condenser in parallel to the circuit
    (d) connecting a resistance in series with the circuit

630. Commercial efficiency of a dynamo is given by
    (a) its electrical efficiency
    (b) its mechanical efficiency
    (c) electrical efficiency × mechanical efficiency
    (d) electrical efficiency/mechanical efficiency

631. Which of the following is not a generator loss
    (a) copper loss (b) iron loss
    (c) hysteresis loss (d) chemical loss

632. In copper loss of a generator the energy is wasted in
    (a) producing eddy currents
    (b) overcoming flux leakage
    (c) overcoming resistance of armature-coils
    (d) overcoming friction

633. Iron-loss in a dynamo arises due to
    (a) the resistance of armature coils
    (b) the production of eddy currents
    (c) the presence of mechanical friction
    (d) leakage of flux

634. EMF generated by a dynamo
    (a) increases as the no. of turns in the coils is reduced
    (b) decreases as the no. of turns in the coils are increased
    (c) increases as the no. of turns in the coil are increased
    (d) none of the above

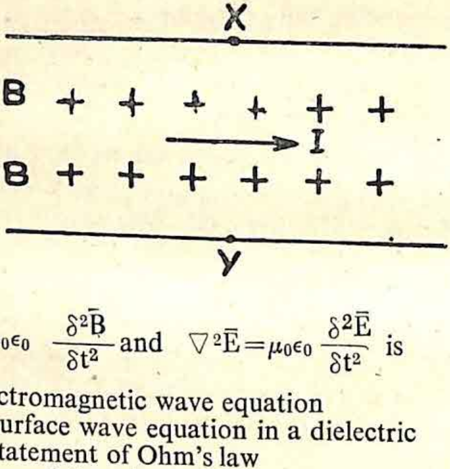
635. Slip rings are used in
    (a) DC dynamo (b) AC dynamo
    (c) don't know

636. Split-ring commutator is typical of
    (a) a DC generator (b) an AC generator
    (c) a transformer (d) a rectifier

637. Electrical efficiency of a DC dynamo increases as the
   - (a) back emf is increased
   - (b) back emf is reduced
   - (c) applied emf is increased
   - (d) back emf reduced by half, applied emf increased by a factor of two

638. Hall effect shows that the majority of current-carriers in a metal should be
   - (a) electrons
   - (b) holes
   - (c) both electrons and holes
   - (d) positrons

639. If a current is flowing through a flat strip metal conductor and it is placed in a B-field going into the conductor (see fig.). Which of the points 'X' or 'Y' will attain a higher potential
   - (a) X (b) Y
   - (c) X & Y will have same potentials



640. $\nabla^2\bar{B} = \mu_0\epsilon_0 \frac{\delta^2\bar{B}}{\delta t^2}$ and $\nabla^2\bar{E} = \mu_0\epsilon_0 \frac{\delta^2\bar{E}}{\delta t^2}$ is
   - (a) electromagnetic wave equation
   - (b) a surface wave equation in a dielectric
   - (c) a statement of Ohm's law
   - (d) none of the adove

641. An ideal capacitor is charged to 50 V and connected across an ideal inductance. Then
   - (a) the capacitor will discharge immediately
   - (b) the capacitor will discharge slowly
   - (c) electrical oscillations will be set up
   - (d) electrical energy will suddenly become zero

642. In an electromagnetic wave
   - (a) power is transferred along the magnetic field
   - (b) power is transferred along the electrical field
   - (c) power is equally transferred along the electrical & magnetic fields
   - (d) power is transferred in a direction perpendicular to both the fields

643. The Maxwell's Equation$\epsilon_0 \oint \bar{E}.d\bar{s} = q$, illustrates
   - (a) Guass's Law for electricity
   - (b) Guass's Law for magnetism
   - (c) Ampere's Law
   - (d) Faraday's Law

644. The Maxwell's Equation, $\oint \bar{B}.d\bar{l} = \mu_0 \left(\frac{\epsilon_0 d \oint E}{dt} + i \right)$ is a statement of
   - (a) Faraday's Law of indution
   - (b) Ampere's Law
   - (c) Guass's Law for electricity
   - (d) Guass's Law for magnetism

645. The Maxwell's Equcation, $\oint \bar{B}.d\bar{s} = o$ is a statement of
   - (a) Guass's Law for magnetism
   - (b) Guass's Law for electricity
   - (c) Ampere's Law
   - (d) Faraday's Law of induction

646. The Maxwell's Equation, $\oint \bar{E}.d\bar{l} = -\frac{\delta \bar{B}}{\delta t}$ is a statement of
   - (a) Ampere's Law
   - (b) Faraday's Law of induction
   - (c) Guass's Law for electricity
   - (d) Guass's Law for magnetism

647. In an oscillating resistanceless circuit containing only L & C, the frequency is determined by
   - (a) the amplitude of the current flowing
   - (b) phase of the current flowing
   - (c) magnitude of the inductance only
   - (d) magnitude of the inductance as well as the capacitance

648. The POYNTING VECTOR gives the direction of
   - (a) electric field
   - (b) magnetic field
   - (c) power flow
   - (d) none of the above

649. Neutrons can be accelerated by
   - (a) a cyclotron (b) synchro-cyclotron
   - (c) Bevatron (d) high speed bombardment

650. The time of passage of a deutron through a dee in a cyclotron is
   - (a) dependent upon its speed
   - (b) independent of its speed
   - (c) independent of the magnetic field
   - (d) independent of its mass

651. If the magnetic field in a cyclotron is halved and the radius of the dees is doubled, then the kinetic energy of the accelerated particles
   - (a) becomes eight times (b) becomes four times
   - (c) becomes double (d) remains the same

652. If the magnetic field in a cyclotron is halved and radius of dees is quadrupled, then the kinetic energy increases by a factor of
   - (a) 4 (b) 8
   - (c) 2 (d) zero

653. Synchro-cyclotron removes which of the following limitations of a cyclotron.
   - (a) magnet's cost-limitations
   - (b) magnet's size-limitations
   - (c) relativistic mass-limitation
   - (d) none of the above

654. Magnetic field in a betatron doesn't serve which of the following purposes
   - (a) it accelerates the electrons in their path
   - (b) it guides the eletrons in a circular path
   - (c) it introduces and removes the electrons from the orbit
   - (d) it decelerates the electrons in their path

655. When a charge is given to a soap bubble, it
   - (a) will increase in size (b) remains the same in size
   - (c) decreases in size (d) collapses

656. The purpose of a choke in a fluorescent lamp is
   - (a) to decrease the current
   - (b) to increase the current
   - (c) to increase the voltage momentarily
   - (d) to decrease the voltage momentarily

657. In the case of a moving coil galvanometer the motion is dead beat since
    - (a) current flowing is small
    - (b) the resistance of the galvanometer is low
    - (c) there are eddy currents produced in the frame over which the coil is wound
    - (d) none of the above

658. The back emf of a motor when it has picked up the maximum speed is
    - (a) slightly greater than the applied emf
    - (b) slightly less than the applied emf
    - (c) equal to the applied emf
    - (d) equal to zero

659. Two tangent galvanometers have the same radii of cross-section but one of them has twice the no. of turns as the other. Then the reduction factor of the first is
    - (a) twice that of the other
    - (b) four times that of the other
    - (c) half that of the other (d) eight times that of the other

660. In an induction coil, the secondary emf is
    - (a) zero at the break of the circuit
    - (b) zero during make of the circuit
    - (c) very high during make of the circuit
    - (d) very high during break of a circuit

661. Two coils are said to be tightly coupled when the coefficient of coupling
    - (a) is less than one (b) is greater than one
    - (c) equal to one (d) equal to infinity

662. The sensitiveness of a moving coil galvanometer can be increased by
    - (a) decreasing the no. of turns of the coil
    - (b) decreasing the area of the coil
    - (c) increasing the couple per unit twist of the suspension
    - (d) increasing the magnetic flux

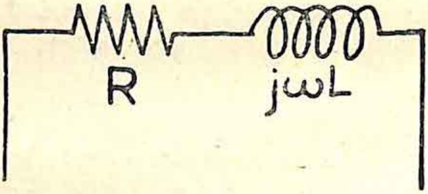
663. In a shunt wound dynamo, the potential difference between field coils when the external load increases
    - (a) increases (b) decreases
    - (c) remains constant
    - (d) oscillates between increase and decrease

664. A straight wire carrying current will experience a force when placed in a uniform magnetic field if
    (a) the current and the field are parallel
    (b) the current and the field are at an angle
    (c) the current and the field are parallel in the opposite directions
    (d) none of the above

665. Tick the correct statement
    (a) Two parallel currents attract
    (b) two like-poles attract
    (c) two anti-parallel currents attract
    (d) there cannot be any force between two currents

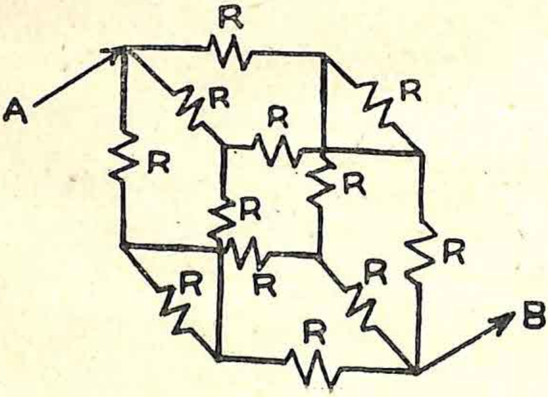
666. You have been given two copper wires, the first being twice as long and having twice the diameter of the second, the resistance of the first will be
    (a) equal to the second (b) twice the second
    (c) half of the second (d) one-fourth of the second

667. The quality factor Q for a RL circuit shown below is given by



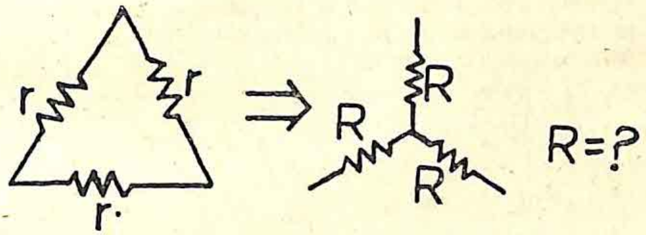
(a) $R/\omega L$ (b) $\omega L/R$
(c) $\omega R/L$ (d) ωRL

668. Twelve identical wires of resistance R are arranged to form the edges of a cube as shown. The equivalent resistance between A and B is



(a) 12 R (b) 6/5 R
(c) 5/6 R (d) 30 R

669. Three resistances r ohms are connected in delta. The resistance R for an equivalent star connection is



(a) 2r (b) 3r
(c) (1/3)r (d) (2/3)r

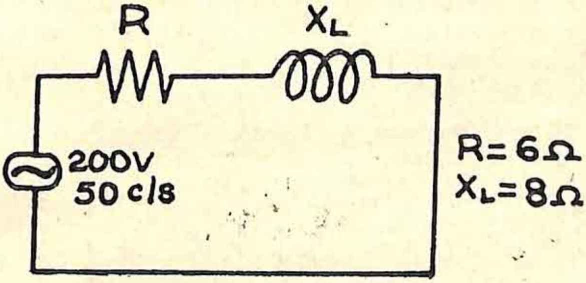
670. A shunt generator has an induced Voltage on open circuit of 127 V. When the machine is on load, the terminal Voltage is 120 V. The armature current if the armature resistance is 0.02 ohm, is

(a) 350 A (b) 342 A
(c) 120 A (d) 127 A

671. A 400 V, shunt motor has an armature resistance of 1 ohm and field resistance of 200 ohms. The back emf when giving an output of 20 amperes is

(a) 400 V (b) 380 V
(c) 382 V (d) 378 V

672. A resistance of 6 ohms is connected in series with a inductive reactance of 8 ohms and put across a 50 c/s, 200 V (rms) supply. The Voltage drop along resistance is



(a) 200 V (b) 120 V
(c) 160 V (d) 20 V

673. The force between two charges, each one coulomb, when they are spaced at one metre distance in air is

(a) 9×90^9 Nω　(b) $9\text{-}2 \times 10^{-2}$Nω
(c) 92×10^4 Nω　(d) 90×10^7Nω

674. Three identical point charges each Q coulombs are placed at the vertices on an equilateral triangle 1 m apart. The force on each charge is

(a) $9 \times 10^9 \; Q^2$ Newtons
(b) $9 \times 10^9 Q^2 \times \sqrt{3/2}$ Newtons
(c) $9 \times 10^9 \times \sqrt{3} \; Q^2$ Newtons
(d) $\sqrt{3} \; Q^2$ Newtons

675. A parallel plate capacitor has plates of area 2m². The air gap between the plates is filled with a dielectric of permittivity 6. The capacity of the parallel plate increases by

(a) 6　(b) 3
(c) 1/6　(d) 1/3

676. Dimensional formula for Resistance is given by

(a) $ML^2T^2Q^2$　(b) $ML^{-1}T^{-2}Q^{-1}$
(c) $ML^2T^{-2}Q^{-2}$　(d) $MT^{-}Q^{2-1}$

677. MKS units for magnetic flux density is

(a) ampere turn/meter　(b) tesla
(c) Henry/meter　(d) Weber

WAVES AND OSCILLATIONS

678. Equation of a simple harmonic motion is given by

(a) $x = a(\sin^2 wt + \cos^2 wt)$
(b) $x = a \sin \cos wt$
(c) $x = a \sin wt$
(d) $x = a^2 \sin \sin wt$

679. A circle is obtained as a Lassajous figure when simple harmonic motions

(a) have the same amplitudes, and a phase difference of $\pi/2$
(b) have the same frequency and a phase difference of π
(c) have the same amplitude, frequency and phase
(d) have the same amplitude, frequency and a phase difference of $\pi/2$

680. A pair of coincident straight lines lying in the second and fourth quadrants is obtained as a lissajous figure when simple harmonic motions

(a) have the same amplitudes and a phase of differences of $\pi/2$
(b) have the same frequency and a phase difference of π
(c) have the same amplitude, frequency and phase
(d) have the same frequency and phase

681. Two simple harmonic vibrations having the same period and a phase difference of $\pi/4$ take place along the x axis and y axis respectively. The Lissajous figure formed is

(a) a circle
(b) a pair of coincident straight line lying in the first and third quadrants
(c) an oblique ellipse lying in the I and III quadrant
(d) an oblique ellipse lying in the II and IV quadrant

682. The nature of the resultant path or the curve traced out due to two simple harmonic motions acting at right angles to one another depends upon

(a) the amplitude
(b) the period
(c) the phase difference between the two component vibrations
(d) all of the above

683. When a particle moves in such a way that its acceleration is always directed towards a fixed point in its path and varies as its displacement from the fixed point, the particle is said to move with

(a) constant acceleration
(b) simple harmonic motion
(c) constant angular momentum
(d) constant angular acceleration

684. Two frequencies A and B form a Lissajous figure. The figure completes its cycle in 10 seconds. Frequency A slightly larger than B is known to be 200 cycles.
The frequency of B is then

(a) 180 cycles (b) 199 cycles
(c) 199.9 cycles (d) 198 cycles

685. The propagation of a sound wave in a gas is represented by the equation

$$\frac{d^2y}{dt^2} = \frac{K}{\rho} \cdot \frac{d^2y}{dx^2}$$

The velocity of the wave is given by

(a) K/ρ (b) ρ/K

(c) $\sqrt{K/\rho}$ (d) $\sqrt{\rho/K}$

686. The slope of the displacement curve, at any point of the particles in a logitudinal wave motion, is a measure of

(a) longitudinal strain
(b) rigidity strain
(c) volumetric strain
(d) Young's Modulus of Elasticity

687. Particle velocity in a longitudinal wave motion is given by

(a) wave velocity x slope of the displaced curve
(b) wave velocity/slope of the displacement curve
(c) wave velocity
(d) slope of the displacement curve

688. The amplitude of a vibrating body situated in a resisting medium

(a) decreases exponentially with time
(b) increases exponentially with time
(c) decreases rapidly with time
(d) remains constant with time

689. $Y_1 = a \operatorname{Sin}(wt + \theta)$ and $Y_2 = a \operatorname{Sin}(wt + 2\theta)$ represent two simple harmonic motions of the same period and amplitude, with a phase difference. This statement is

(a) correct (b) incorrect
(c) cannot be said

690. A simple pendulum is vibrating in an evacuated chamber. It will

(a) Oscillate for ever with the same amplitude and frequency
(b) come to rest eventually
(c) oscillate at the same frequency but the amplitude will decrease with time
(d) oscillate with the same amplitude but its frequency will decrease with time

691. $Y=10 \ \mathrm{Sin}(\pi\times 0.01x-\pi\times 2.00t)$, is an equation of a progressive wave of wave-length

(a) 100 cms (b) 200 cms
(c) 150 cms (d) 250 cms

692. Wave motion in which the particles of the medium vibrate about their mean positions in a direction at right angle to the direction of propagation of the wave is

(a) a longitudinal wave motion
(b) stationary wave
(c) transverse wave motion
(d) none of the above

693. In Longitudinal wave motion

(a) the particles of the medium vibrate, about their mean positions, at right angle to the direction of propagation
(b) the particles of the medium vibrate, about their mean positions, in the same direction in which the wave is propagated
(c) the particles of the medium do not vibrate at all
(d) the particles vibrate in a position in between the direction of propagation and at right angle to the direction of propagation

694. Tick the incorrect statement

In Longitudinal progressive wave motion

(a) each particle vibrates to and fro about its mean position with the same amplitude and period
(b) there is a progressive change of phase as we go from one particle to the next
(c) the to and fro motion of the particles produces condensation and rare-faction which travels in the direction in which the wave is propagated
(d) the energy travels in a direction at right angles to the direction of propagation

695. Two simple harmonic vibrations of the same frequency and amplitude having a phase difference of $\pi/2$ and acting at right angles will combine to form a resulting vibration which is

(a) circular (b) elliptical
(c) linear (d) para-bolic

696. A string is stretched between two points and is plucked in a direction at right angles to its length, the vibration produced is
   - (a) longitudinal vibration
   - (b) the string does not vibrate
   - (c) transverse vibration
   - (d) none of the above

697. The velocity of a transverse wave along a string of mass per unit length "m" and stretched with tention T is given by
   - (a) T/m (b) m/T
   - (c) $(T/m)^2$ (d) $\sqrt{T/m}$

698. When a string of length 'l' and mass 'm' per unit length is stretched by a force T, its frequency is given by (if p is the number of segments in which the string vibrate)
   - (a) $(1/21)\sqrt{T/m}$ (b) $(p/21)\sqrt{T/m}$
   - (c) $21\sqrt{T/m}$ (d) $(21/p)\sqrt{T/m}$

699. The total energy of a particle executing Simple harmonic motion is directly proportional to
   - (a) the amplitude
   - (b) the square root of amplitude
   - (c) the square of the amplitude
   - (d) the reciprocal of the amplitude

700. In a Simple harmonic motion we have the conservation of
   - (a) kinetic energy (b) potential energy
   - (c) total energy (d) electrical energy

701. In the vibrations of stretched strings, the frequency is
   - (a) directly proportional to the diameter of the wire
   - (b) inversly proportional to the diameter of the wire
   - (c) directly proportional to the density of the wire
   - (d) inversely proportional to the diameter and square root of density of the wire

702. In Melde's experiment if the tension is adjusted so that the string vibrates as a whole in one segment, the frequency of the string is
   - (a) half that of the tuning fork
   - (b) double that of the tuning fork
   - (c) four times that of the tuning fork
   - (d) one-fourth that of the tuning fork

703. In Melde's experiment, if the tuning fork is turned through 90 degrees and the tension adjusted so that the string vibrates as a whole in one segment, the frequency of the string is

(a) more than that of the tuning fork
(b) less than that of the tuning fork
(c) equal to that of the tuning fork
(d) twice of that of the tuning fork

704. In Melde's experiment, a weight of 10 gm on the pan produces 5 loops, thus 10 loops are produced when a weight of——is placed on the pan.

(a) 20 gm (b) 2.5 gm
(c) 2 gm (d) 10 gm

705. In a tranverse arrangement, a stretched string vibrates in two loops. If the same string under the same tension vibrates in one loop, the frequency in latter case divided by the frequency in the former case will be

(a) 1 (b) 1/2
(c) 2 (d) $\sqrt{2}$

706. If in a stretched string arrangement the area of cross section of the wire is halved and the tension is doubled, the frequency becomes

(a) n/2 (b) $\sqrt{n}$
(c) 2n (d) n^2

707. The velocity of a longitudinal wave in a fluid (when E is the coefficient of volume elasticity of the medium and 'ρ' its density) is given by

(a) $v=\sqrt{E/\rho}$ (b) $v=E/\rho$
(c) $v=\rho/E$ (d) $v=\sqrt{\rho/E}$

708. Air has a density of 0.001293 gm/c.c. At normal pressure $P=76$ cm of mercury the velocity of sound in air as obtained through Newton's formula, is

(a) 332 meters/sec (b) 280 meters/sec
(c) 300 meters/sec (c) 250 meters/sec

709. Velocity of sound as obtained through Newton's formula, is much less than the experimental value. This is due to the fact that

(a) Newton committed a basic methematical mistake
(b) Sound travels in air as a transverse wave motion

(c) Propagation of sound waves in a gas takes, place under isothermal conditions.
(d) Propagation of sound wave in a gas takes, place under adiabatic conditions

710. Velocity of sound as per Laplace's formula is

(a) $v=\gamma\sqrt{p/\rho}$ (b) $v=\sqrt{\gamma p/\rho}$
(c) $v=p\sqrt{\gamma/\rho}$ (d) $v=\rho\sqrt{\gamma/p}$

711. Velocity of sound in a gas is

(a) directly proportional to the pressure
(b) inversely proportional to the pressure
(c) independent of the pressure
(d) proportional to the square root of the pressure

712. Velocity of sound in a gas is

(a) directly proportional to the absolute temperature
(b) inversely proportional to the absolute temperature
(c) directly proportional to the square root of the absolute temperature
(d) independent of the temperature of the medium

713. The ratio of the velocity of sound in hydrogen to the velocity of sound in oxygen is

(a) 4 : 1 (b) 16 : 1
(c) 2 : 1 (d) 8 : 1

714. On a windy day

(a) velocity of sound increases in the direction opposite to the direction of wind
(b) velocity of sound increases in the direction of wind
(c) velocity of sound is independent of the wind speed

715. Effect of moisture on the velocity of sound is to

(a) increase it
(b) decrease it
(c) maintain constant velocity
(d) none of the above

716. Velocity of sound in vacuum is

(a) zero (b) infinity
(c) 332 m/sec (d) 280 m/sec

717. If C is the root mean square velocity of the gas molecule and r the ratio of the two specific heats, the velocity of sound in terms of C and r is given by

(a) $cr/3$ (b) $r\sqrt{c/3}$
(c) $c\sqrt{r/3}$ (d) $\sqrt{cr/3}$

718. The velocity of sound in air at N.T.P., for the ratio of specific heat for air = 1.4, is

(a) 224 m/sec (b) 332 m/sec
(c) 228 m/sec (d) 300 m/sec

719. When the two waves of the same amplitude meet in opposite phase, the crest of one falls over the trough of the other, the interference is then said to be

(a) constructive
(b) destructive
(c) effect is not exhibited

720. A ship which approaches a fog siren installed on a high cliff observes a silence zone in which no sound is heard from the siren. This is because

(a) the intensity of sound being low at such a distance
(b) the sound from the siren gets mixed up with the sound from the sea waves
(c) sound reaching different path causes destructive interference in these zones
(d) cannot be said

721. When the prongs of a vibrating tuning fork are made to touch the surface of a liquid, the interference frings are

(a) circular (b) parabolic
(c) elliptical (d) hyperbolic

722. When two waves of nearly the same frequency travel along the straight line in the same direction the resultant displacement at a point alternately waxes and wanes in amplitude as many times per second as the difference in their frequency. This phenomenon is known as

(a) Beats (b) Doppler's effect
(c) Joule's effect (d) Newton's effect

723. The beats cannot be heard seperately, owing to the persistance of hearing when the number of beats is more than

(a) 10 per second (b) 12 per second
(c) 4 per second (d) 16 per second

724. The effect of attaching a little wax to the prong of a tuning fork is to
   (a) increase its frequency of vibration
   (b) decrease its frequency of vabration
   (c) maintain constant frequency of vibration
   (d) increase the amplitude of vibration

725. A fork of unknown frequency gives 4 beats per second when sounded with another fork of frequency 256. When loaded with wax number of beats heard still remains the same. Therefore the unknown frequency is
   (a) 252 (b) 256
   (c) 260 (d) 264

726. The velocity of sound in a gas in which two waves of wavelength 50 cm and 50.5 cm produce 6 beats per second, is
   (a) 303 m/sec (b) 332 m/sec
   (c) 296 m/sec (d) 228 m/sec

727. Two organ pipes when sounded together produce 3 beats per second. The two pipes are of length 25 cm and 25.25 cm long. Their frequencies are
   (a) 300 c/sec and 350 c/sec
   (b) 30 c/sec and 33 c/sec
   (c) 235 c/sec and 238 c/sec
   (d) 265 c/sec and 278 c/sec

728. In the envelope of a standing wave, the distance between any two antinodes is equal to
   (a) λ (b) $\lambda/4$
   (c) $\lambda/2$ (d) $3\lambda/4$

729. A wave of frequency 500 cycles/sec has a phase velocity of 350 meters/sec. How far apart are the two points 60° out of phase
   (a) 10 cm (b) 12 cm
   (c) 8 cm (d) 14 cm

730. Tick the correct statement about progressive waves
   (a) The amplitude of each particle is not the same. It is maximum at an antinode and decreases gradually from an antinode to the node according to the cosine law
   (b) Particles at the nodes are permanently at rest. Other particles are also momentarily at rest at the extreme position of their displacements.

(c) All the particles have the same maximum velocity which they have on passing through their mean positions one after the other

(d) the velocity at the nodes is always zero

731. Tick the correct statement about a stationary wave

(a) Each particle has the same constant amplitude. The phase varies along the wave

(b) No particle is permanently at rest

(c) Every region passes successively through conditions of compression, normal density and rarefaction and these conditions travel forward

(d) The velocity at the nodes is always zero

732. In a stationary wave in closed pipe, the positions of nodes are

(a) $n\lambda/2$ (b) $(2n+1)\,\lambda/4$

(c) $(2n-1)\lambda/4$ (d) $3\lambda/4$

733. Time period of vibration of a simple pendulum is given by

(a) $2\pi\sqrt{g/1}$ (b) $\sqrt{2\pi g/1}$

(c) $2\pi\sqrt{1/g}$ (d) $\pi\sqrt{1/g}$

734. The minimum length of a pipe open at both the ends required to set the air column in the pipe into vibrations (if V is the velocity of the sound, in air, and n the frequency of the vibrations), is

(a) $V/2n$ (b) $2V/n$

(c) V/n (d) $2Vn$

735. Overtones are

(a) the fundamental produced in a pipe

(b) the notes produced in a pipe other than the fundamental

(c) nothing but beats

(d) none of the above

736. Sound produced by an open pipe contains

(a) fundamental component only

(b) only odd harmonics

(c) all the harmonics

(d) only even harmonics

737. Sound produced by a closed pipe contains
   (a) all the harmonics
   (b) only odd harmonics
   (c) only fundamental components
   (d) even harmonics only

738. The effect of diameter on pitch in the case of open pipes is
   (a) no effect
   (b) a narrower open pipe produces a lower frequency
   (c) a wider open pipe produces a lower frequency than a narrower pipe of the same wavelength
   (d) a wider open pipe produces a higher frequency

739. The quality of note produced
   (a) is the best from a wider pipe
   (b) by a narrower pipe is not as good as that produced in a wider pipe
   (c) by both the wider pipe and the narrower pipe are the same
   (d) by a narrower pipe is better than that produced by a wider pipe

740. The wave-length 'λ' of the fundamental note of a closed organ pipe is given by
   (a) 1
   (b) 21
   (c) 41
   (d) 1/2

741. A closed pipe one metre long containing a gas resounds in its fundamental note to a tuning fork of frequency 100 cycles per second. The velocity of sound in the gas is
   (a) 400 m/sec
   (b) 330 m/sec
   (c) 280 m/sec
   (d) 100 m/sec

742. According to Doppler effect, when a sounding body produces a note of frequency 'n', a listener at a distance
   (a) receives 'n' waves per second if he is moving against the direction of sound
   (b) receives 'n' waves per second if he is moving toward the direction of the sound
   (c) receives 'n' waves per second if he is at rest
   (d) receives 'n' waves per second irrespective of whether he is stationary or moving

743. The apparent change in frequency due to a relative motion between the source and the observer is known as

(a) Newtonion principle (b) Doppler's principle
(c) Laplace's principle (d) Sabine's principle

744. If the source moves towards the listener (in the same direction in which the sound is travelling) with a velocity b, then the reduced wave-length is given by the expression (n = frequency of note produced by the source)

(a) $(V-b)/n$ (b) $(V+b)/n$
(c) $n(V-b)$ (d) $n(V+b)$

745. An observer is moving towards the source of sound at a velocity C. The apparent frequency of the sound which he listens is (V=velocity of sound, n=frequency of the sound source)

(a) $(V-C)n/V$ (b) $(V+C)n/V$
(c) Vn/C (d) $V(n-1)/C$

746. When the source and the listener are both in motion

(a) the former causes a change in wave length and the latter a change in the number of waves received
(b) the former causes a change in the number of waves received and the latter a change in wave-length
(c) the wavelength and the number of waves received remains same
(d) only the number of waves received changes

747. Mark the correct statement

(a) the frequency of the note heard is same in both the cases when the listener is at rest with source moving or when the source is at rest with listener moving
(b) when the listener is moving with source at rest, the frequency of the note heard is greater than when the listener is at rest with source moving
(c) when the listener is moving with source at rest the frequency of the note heard is less than that when the listener is at rest with source moving
(d) none of the above statements is true

748. An engine blowing a whistle of frequency 100 c/s moves with a velocity of 120 ft/sec towards a hill. The frequency of the whistle heard by an observer at the hill if the velocity of sound in air is 1120 ft/sec is

(a) 112 c/s (b) 100 c/s
(c) 120 c/s (d) 1120 c/s

749. Ultrasonics are the

(a) frequencies in the audiable range
(b) frequencies greater than 20 MHZ, above the limits of human audiability
(c) frequencies below 20 MHZ
(d) frequencies in the range of 5 to 15 MHZ

750. Kundt's tube offers a good method for the determination of velocity of sound. It provides an easy means to determine

(a) the velocity of sound in liquids
(b) Young's modulus of solid
(c) the ratio of specific heats in different gases.
(d) all of the above

751. The frequency of the tuning fork is

(a) dependent upon its dimensions and elastic constants.
(b) independent of its dimensions
(c) independent of elastic constant
(d) independent of its dimensions and elastic constants

752. As the temperature increases the frequency of a tuning fork

(a) increases (b) decreases
(c) remains same

753. As the temperature increases the frequency of a tuning fork remains the same, if it is made up of

(a) soft iron (b) nickel
(c) nickel steel alloy (d) Gun metal

754. In Stroboscopic method of measuring the frequency of a tuning fork, the disc having "p" dots rotates at a rate of "m" revolutions per second. The frequency of the tuning fork is

(a) m (b) p
(c) m/p (d) mp

755. The quality of musical note depends upon

(a) the number of over tones
(b) the relative frequencies of overtones
(c) the relative intensities of overtones.
(d) all of the above

756. Frequencies less than 20 cycles per second are called

(a) Supersonics (b) Ultrasonics
(c) infra sonics (d) infra red wave

757. Work done in displacing the centre of a stretched string by an amount 'h'
   - (a) equals the sum of the energies present in the various modes of vibration when the string is released
   - (b) equals the potential energy possessed by the string
   - (c) equals the kinetic energy possessed by the string
   - (d) equals the difference of kinetic energy and potential energy possessed by the string

758. An octave is
   - (a) the interval between two tones when the frequency of one equals to that of the other
   - (b) the interval between two tones when the frequency of one is just twice to that of the other
   - (c) the interval between two tones when the frequency of one is eight times that of the other

759. The frequency of maximum sensitivity for normal ears is in the vicinity of
   - (a) 3000 c/s (b) 20,000 c/s
   - (c) 300 c/s (d) 1000 c/s

760. The unit of loudness level is
   - (a) bel (b) decibel
   - (c) phon (d) volts

761. Reverberation time of an enclosure is
   - (a) the time in seconds required to reduce the intensity 60 db after the source of sound has stopped
   - (b) the time in seconds required to achieve maximum echo
   - (c) the time in seconds required to achieve minimum echo
   - (d) the time in seconds required to die down the sound

762. Sabine's equation used for calculating the reverberation time of a room, if the room has volume V and total absorption a, is given by
   - (a) 0.1 V/a (b) V/a
   - (c) a/V (d) 0.049 V/a

763. The optimum reverberation time in an ordinary room is
   - (a) 5 to 6 sec (b) 1 to 2 sec
   - (c) 10 to 15 sec (d) 12 to 18 sec

764. A 2 Kg weight stretching on a string produces a note of frequency 125 C/sec. When the weight is increased to 8 Kg the frequency becomes
   - (a) 125 C/sec (b) 62.5 C/sec
   - (c) 250 C/sec (d) 500 C/sec

765. The amplitude at resonance of a vibrating body situated in the air becomes

(a) infinite (b) maximum
(c) zero (d) minimum

766. The amplitude at resonance of a vibrating body placed in a damping medium becomes

(a) infinite (b) maximum
(c) minimum (d) zero

767. The velocity of longitudinal vibrations in a solid depends upon its

(a) Rigidity modulus (b) Bulk modulus
(c) Young's modulus (d) Poisson's ratio

768. When sound waves travel from rarer medium to denser medium the quantity that remains unchanged is

(a) speed (b) frequency
(c) intensity (d) wave-length

769. A police constable is whistling with a sound frequency 300 c/sec when a car is approching him with a speed of 0.01 M. P. Sec, the frequency of the sound that the driver in the car hears is (Assuming Velocity of Sound in air 0.6 miles/sec)

(a) 305 c/sec (b) 300 c/sec
(c) 280 c/sec (d) 330 c/sec

670. When two or more notes are sounded together the resultant note due to their combination is called a

(a) beat (b) stationary note
(c) chord (d) frequency

771. Two sound waves give rise to the phenomenon of beats due to their

(a) reflection (b) refraction
(c) interference (d) diffraction

772. A sound of 2 C/sec

(a) has very short wave-length
(b) is inaudible
(c) moves very slowly
(d) is very loud

773. If two vibrating systems are in resonance then their

(a) amplitudes are equal
(b) temperatures are equal
(c) resistances are equal
(d) frequencies are equal

774. Helmholtz's resonator is used to

(a) find out the velocity of sound
(b) analyse a sound note
(c) amplify a sound note

775. Quality of note changes when change occurs in

(a) pitch
(b) nature of overtones
(c) loudness
(d) wave-length

776. The amplitude at resonance of a vibrating body placed in vacuum is

(a) infinite (b) maximum
(c) minimum (d) zero

777. When two tuning fork of nearly the same frequncies are sounded, beats are produced. The beats

(a) travel with velocity of sound
(b) travel with a velocity smaller than that of sound
(c) travel with a velocity larger than that of sound
(d) do not travel at all

778. Two tuning fork have to be very accurately in unison to show resonance while a tuning fork and an air column require to be only approximately tuned. This is so because

(a) the damping is large in the case of air column, on the other hand it is small in the case of a tuning fork
(b) The damping is small in the case of air column
(c) the damping in the case of tuning fork is large
(d) the statement is wrong

779. If F is the applied force per unit mass, $p/2\pi$ the frequency of the applied force and "k" the damping co-efficient. The amplitude of forced vibration at resonance is

(a) $F/2\pi kp$ (b) $F/2kp$
(c) $2kp/F$ (d) $2kp/\pi F$

780. The time of reverberation of a hall can be decreased by

(a) choosing a larger hall
(b) having a number of loud speakers
(c) opening all windows and doors
(d) speaking loudly

781. For obtaining good acoustic property a hall should have
   (a) zero reverberation
   (b) large reverberation
   (c) small but non-zero reverberation

782. A stationary wave is set up in the air column of a closed pipe. At the closed end of the pipe
   (a) always an antinode is formed
   (b) always a node is formed
   (c) sometimes a node and sometimes an antinode is formed

783. In a velocity determination experiment with a resonance tube, the first and second resonance columns with a tuning fork of frequency 500 C/sec are 18 cm and 48 cm respectively. The velocity of sound is
   (a) 280 m/sec
   (b) 300 m/sec
   (c) 250 m/sec
   (d) 325 m/sec

784. The total energy per wave-length in a stationary wave is
   (a) double that in a progressive wave
   (b) is zero
   (c) is the same as that in a progressive wave
   (d) is infinite

785. A vertical U-shaped tube of uniform cross-section contains water upto a height of 50 cm. Water on one side is depressed and then. released. If the tube is assumed to be frictionless, the motion will be (of the water column)
   (a) damped
   (b) forced
   (c) free
   (d) simple harmonic

786. The two parts of a sonometer wire, divided by a movable knife edge are of length 45 cm and 44 cm. If they produce one beat per second when sounded together, their frequencies are in the ratio of
   (a) 45 : 44
   (b) 90 : 44
   (c) 45 : 88
   (d) 135 : 44

787. When a particle is moving in simple harmonic motion
   (a) it has uniform velocity at every point
   (b) its velocity at a distance 3/2 of its amplitude from its central position is half its velocity in the central position
   (c) the acceleration of the particle is always directed away from a fixed point
   (d) none of the above

788. The damping of an excited tuning fork is due to

(a) shape of the fork
(b) length of the prong of the fork
(c) elastic forces in the fork
(d) air current

789. The property of sound that is affected by change in air temperature is

(a) wavelength (b) frequency
(c) amplitude (d) intensity

790. Sound waves cannot be

(a) reflected (b) refracted
(c) diffracted (d) polarised

791. Sound reproduction from phonofilm is made on the priciple of

(a) photo-electric effect (b) fluorescence effect
(c) thermionic effect (d) resonance effect

792. A singing flame is

(a) a jet introduced into a gas tube
(b) a jet attached to a Helmhotz resonator
(c) a jet burning under high pressure
(d) a manometer capsule

793. The pitch of the note in a singing flame, if 'l' is the length of the open pipe and 'v' the velocity of sound in air, is v/2l. To obtain a musical note, the length of the jet tube must be

(a) an even multiple of $\lambda/4$
(b) an odd multiple of $\lambda/4$
(c) a multiple of $\lambda/2$
(d) a multiple of λ

794. A close pipe 4 ft long full of a certain gas resounds to a given tuning fork. The wave-length is then equal to

(a) 4 ft (b) 8 ft
(c) 16 ft (d) 2 ft

795. The frequency of transverse vibrations of a stretched string is 200 Hz. If the tension is increased four times, the frequency becomes

(a) 800 Hz (b) 50 Hz
(c) 400 Hz (d) 100 Hz

796. One of the practical application of reflection of sound is
   (a) speaking tube
   (b) Ear trumpet
   (c) The sound board
   (d) all the examples above are practical applications of reflection of sound

797. Helmholtz's resonators are
   (a) the resonance box of a tuning fork
   (b) an open organ pipe
   (c) a closed organ pipe
   (d) turnip shaped resonators

798. The ratio of fundamental frequency of an organ pipe open at both ends to that of the organ pipe closed at one end is
   (a) 1 : 2   (b) 3 : 2
   (c) 2 : 1   (d) 1 : 1

799. A man standing between two parallel hills fires a gun and hears two echoes, one 2.5 second and the other 3.5 second after the firing. If the velocity of sound is 330 metres/sec, the distance between the two hills is
   (a) 330 metres   (b) 660 metres
   (c) 990 metres   (d) 1320 metres

800. In a new cinema theatre, it is observed that there is an overlapping of the voice of the speaker and the speech heard is unintelligible. Then a specialist in accoustics will suggest
   (a) reduction of seating capacity in the theatre
   (b) increase of sound intensity in the theatre
   (c) abondonment of the theatre
   (d) increase of cushioned chairs in the theatre

6

ATOMIC PHYSICS

801. Radioactivity is
   (e) a spontaneous activity
   (b) self-disruptive activity
   (c) exhibited by all elements under proper conditions
   (d) both 'a' and 'b' above

802. Radioactivity can be intensified by

    (a) increasing the temperature of the element
    (b) increasing the electric field surrounding it
    (c) adiabatic demagnetisation
    (d) none of the above

803. Tick the incorrect statement in relation to radioactivity

    (a) radioactivity consists in the emission of alpha, beta and gamma rays
    (b) it is a spontaneous and self-disruptive activity
    (c) In nature, it is exhibited by elements of atomic weights higher than 206 only
    (d) it is a reversible activity

804. Radium, one of the radioactive elements can be extracted from

    (a) haematite ore (b) pitchblede ore
    (c) magnetite ore

805. The radiations that had affected the photographic plate in Bacquerrel' accidental discovery were

    (a) alpha rays (b) beta rays
    (c) gamma rays (d) X-rays

806. Radioactivity

    (a) is an atomic property
    (b) is exhibited more by the elements when they are coupled with other radioactive elements by a covalent bonds
    (c) is exhibited more by semiconductors in general
    (d) none of the above

807. Which of the following is not included in the 'displacement law':

    (a) In all known radioactive transformations either an alpha or beta particle is emitted by the atom
    (b) When an alpha particle is emitted, a new atom is formed whose mass number is less by four units and atomic number more by two units than those of the parent atom
    (c) When a beta particle is emitted, the new atom formed has the same mass number
    (d) In beta ray emission the atomic number increases by one

808. If $_{90}Th^{232}$ disintegrates by an alpha emission, the new element formed is

(a) $_{89}MsTh_2{}^{228}$ (b) $_{88}MsTh_1{}^{228}$
(c) $_{88}RdTh^{228}$ (d) $_{88}ThX^{224}$

809. If $_{88}MsTh_1{}^{228}$ disintegrates by a beta emission, the new element formed is

(a) $_{89}MsTh_2{}^{228}$ (b) $_{88}RdTh^{228}$
(c) $_{88}ThX^{224}$ (d) $_{86}Tn^{220}$

810. The stable end product of each of the three radioactive series is the element

(a) Gold (b) Lead
(c) Platinum (d) Polonium

811. Curie is defined as the activity of one gram of radium in which . ...atoms disintegrate per second

(a) 3.5×10^{10} (b) 3.71×10^{10}
(c) 3.71×10^{9} (d) 3.50×10^{9}

812. The law governing radioactive disintegration is given by

(a) $N_0 = N_t e^{-\lambda t}$ (b) $N_t = N_0 e^{\lambda t}$
(c) $N_t = N_0 e^{-\lambda t}$ (d) $N_t/N_0 = (1 + e^{-\lambda t})$

where N_t = no. of radioactive atoms at the time 't'
and N_0 = initial no. of atoms

813. Half-period time of a radioactive element is defined as the time in which the radioactive atoms are reduced to half their initial value and is given by

(a) 0.693λ (b) 0.603λ
(c) $0.603/\lambda$ (d) $0.693/\lambda$

where 'λ' is the disintegration constant

814. Half period time of radium is 1590 years. In how many years shall the earth lose this element because of radioactive decay

(a) 1590×10^{6} years (b) 1590×10^{12} years
(c) 1590×10^{24} years (d) never

815. The mean life time of an atom is given by

(a) 0.693λ (b) $0.693/\lambda$
(c) λ (d) $1/\lambda$

816. If 1590 years is the half period time for radium, what is its mean life time

(a) 23,000 years (b) 25,000 years
(c) 2,300 years (d) 2,500 years

817. Thorium emits 455 alpha particles per second per gram. If 1 gm of thorium contains 2.25×10^{21} atoms, the disintegration constant is

(a) 20×10^{-13} sec.$^{-1}$ (b) 2×10^{-18} sec.$^{-1}$
(c) 2×10^{-15} sec.$^{-15}$ (d) 20×10^{-20} sec.$^{-1}$

818. Alpha rays consist of

(a) moving positive particles
(b) moving negative corpuscles
(c) moving neutral particles
(d) some negative and positive particles

819. Which of the following radiations possesses maximum velocity

(a) alpha (b) beta
(c) gamma

820. Geiger's Law on range and velocity is given by

(a) $R = a\ v^3$ (b) $R = a\ v^2$
(c) $R/a = v^2$ (d) $R/a^3 = v$

821. Which of the following radiations possesses maximum ionising power

(a) alpha (b) beta
(c) gamma

822. ....radiation has the maximum penetration power

(a) alpha (b) beta
(c) gamma

823. Which of the following radiation gives a continuous spectrum

(a) alpha (b) beta
(c) gamma

824. Gamma rays are electro-magnetic radiations of very high frequency

(a) true (b) false
(c) don't know

825. Transuranic elements are

(a) those having atomic number as 92
(b) those having atomic number greater than 92
(c) those having atomic number greater than 100
(d) ratioactive isotopes of Uranium

826. Which of the following rays can be detected by a magnetic field

(a) gamma rays (b) radio-waves
(c) beta rays (d) infrared rays

827. Alpha particles consist of

(a) 1 proton and 1 neutron
(b) 2 proton and 2 neutron
(c) 2 proton and 1 neutron
(d) 2 protons only

828. In nuclear transmutations, both natural and artificial, as well as nuclear fission, the nucleus is broken into two pieces. Then the difference between fission and nuclear transmutations is

(a) nuclear transmutations absorb energy at break off while fission releases energy
(b) in nuclear transmutation the nucleus is merely chipped off while in fission it breaks into two large pieces
(c) nuclear transmutation is reversible while fission is not
(d) nuclear transmutation is irreversible while the fission process is reversible in the form of fusion process

829. Which of the following is a fission reaction:

(a) ${}_7N^{10}+{}_0n^1\longrightarrow{}_6C^{12}+{}_1H^3$
(b) ${}_7N^{14}+{}_0n^1\longrightarrow{}_6C^{14}+{}_1H^1$
(c) ${}_{92}U^{238}+{}_0n^1\longrightarrow{}_{56}Ba+{}_{36}Kr+{}_0n^1$
(d) ${}_5B^{11}+{}_1D^2\longrightarrow{}_5B^{12}+{}_1H^1$

830. A nucleus is analogous to a drop of liquid in ways such as density, short range forces, packing of particles etc. All these endow to the nucleus a property equivalent to

(a) viscosity (b) surface tension
(c) bulk's elasticity (d) rigidity elasticity

831. Which one of the following is not a result reached by Bohr and Wheeler concerning the fission and fusion processes

(a) surface tension forces predominate in the nulei of all elements in the first half of the periodic table
(b) all nuclei of mass greater than 110 are potentially unstable
(c) nuclear fission results in energy release but fusion, the reverse process results in energy absorption
(d) light nuclei show the phenomenon of fusion

832. Which of the following isotopes of Uranium is responsible for fission by the slow moving neutrons

(a) U^{235} (b) U^{236}

(c) U^{238}

833. Thermal neutrons are those neutrons with energies

(a) more than 1.2 Mev

(b) less than 1.0 eV

(c) between 1 eV and 1.2 MeV

(d) equal to 0.9 eV

834. For producing fission in U^{238}, we need

(a) thermal neutrons

(b) fast neutrons

(c) slow neutrons

(d) particles other than neutrons

835. Release of fission energy results due to the destruction of in the nucleus:

(a) gravitational forces (b) electrostatic forces

(c) mass

836. Moderators in a fission process slow down the fast neutrons and make it easy to produce fission in

(a) U^{235} (b) Th^{233}

(c) Natural Uranium (d) U^{239}

837. Which of the following material can be used as an arrester in a nuclear reactor

(a) graphite (b) heavy water

(c) Uranium (d) cadmium

838. An arrester in a nuclear reactor

(a) aids in the fast multiplication of slow moving neutrons

(b) slows down fast neutrons to avoid non-radiative capture

(c) absorbs the slow moving neutrons

(d) decreases the fission cross section of the neutrons

839. Which of the following nuclear reactors shall have the smallest size

(a) heavy water and natural uranium

(b) graphite and natural uranium

(c) graphite and enriched uranium

(d) heavy water and enriched uranium

840. The atom bomb is an example of

(a) controlled nuclear fission
(b) controlled nuclear fusion
(c) uncontrolled nuclear fission
(d) uncontrolled nuclear fusion

841. Which of the following can be called as clean bombs (those who do not spread radioactivity)

(a) atom bomb (b) hydrogen bomb
(c) neutron bomb (d) both 'b' & 'c' above

842. X-rays are said to be hard if the value of the absorption coefficient is

(a) small
(b) large
(c) hardness of X-rays is unaffected by the absorption coefficient
(d) none of the above

843. If X-rays are passed through successive aluminium sheets, their hardness

(a) increases (b) decreases
(c) remains unaffected

844. When X-rays are absorbed, they give rise to secondary radiations. Which one of the following is not a secondary radiation

(a) scattered rays
(b) fast moving electrons
(c) characteristic X-rays
(d) fast moving neutrons

845. Bragg's Law for X-ray reflection is given by

(a) $n\lambda=2d \sin \theta$ (b) $n\lambda=\sin \theta$
(c) $\lambda= d \sin \theta$ (d) $n\lambda=2d \sin 2\theta$

846. Tick the wrong statement in relation to an X-ray spectra

(a) The intensity of the reflected ray increases as the order of the spectrum increases
(b) The position of peaks in the spectrum depend upon the material used in the production of X-rays
(c) The position of the peaks depends upon the particular face of the crystal used
(d) the intensity of the reflected beam never falls to zero

847. The magnitude of an X, Unit is

(a) 10^{-8} cm (b) 10^{-9} cm
(c) 10^{-10} cm (d) 10^{-11} cm

848. The continuous X-ray spectrum is determined by

(a) the type of the material used
(b) the pressure inside the tube
(c) the voltage across the tube
(d) none of the above

849. As the excitation voltage across an X-ray tube increases, the minimum wave-length of the X-rays obtainable

(a) increases
(b) decreases
(c) remains unaffected
(d) first increases and decreases exponentially

850. Bohr's theory as applied to the X-ray spectra infers that X-rays arise due to.... of an atom.

(a) outer electrons
(b) closely bound near to the nucleus electrons
(c) neutrons in the nucleus itself
(d) electrons in the nucleus itself

851. K_β line in an X-ray spectra will arise when an electron from

(a) the K-shell goes to the L-shell
(b) the M-shell goes to the K-shell
(c) the M-shell goes to the L-shell
(d) the N-shell goes to the K-shell

852. A ruled grating can be used for the dispersion of X-rays

(a) True (b) False
(c) can not be said

853. Tick the incorrect statement

(a) Beta-particle is same as electron
(b) Alpha-particles have shortest range in the air
(c) Neutrons are usually accelerated in cyclotrons
(d) Electrons cannot travel faster than photons

854. X-ray is similar to

(a) cathode rays (b) gamma rays
(c) alpha rays (d) a neutron stream

855. The position of Potassium and Argon in the periodic table was interchanged as a result of the study of

(a) Raman effect (b) Compton effect
(c) Laue Pattern (d) Moseley's Law

856. Gamma rays are

(a) electromagnetic radiations of high frequency
(b) like fast moving electrons
(c) like fast moving photons
(d) neutral particles with mass number unity

857. X-rays are produced when

(a) beam of electrons strikes the target
(b) an electron excited from the inner orbit of a heavy atom returns to that orbit
(c) an atom is doubly ionised
(d) an atom undergoes fission

858. A positron has the same mass as

(a) an electron (b) a proton
(c) a neutron (d) an epsilon

859. Two parallel beams of electrons moving in the same direction will

(a) repel each oth er
(b) attract each other
(c) not interact at all
(d) none of the above

860. An electron from a light element, say Helium atom

(a) is identical to an electron from a heavy element, say Thorium
(b) is heavier than an electron from a Thorium atom
(c) is larger in size than an electron from a Thorium atom
(d) is smaller in size than an electron from a Thorium atom

861. In the modern periodic table, the elements have been arranged in the order of increasing

(a) atomic mass (b) atomic number
(c) no. of neutrons (d) both 'a' and 'b' only

862. Moseley' Law relates

(a) wave-lenghth and intensity of X-rays
(b) frequency and applied voltage for an X-ray tube
(c) frequency and atomic number
(d) frequency and atomic weight

863. X-rays can be used

(a) for boring, cutting and welding with precision
(b) for retina stitching in eye operations

(c) to detect heavy elements under the earth
(d) to detect flaws in casting and welding

864. The suggestion that a crystal can be used as diffraction grating for X-rays was given by

(a) Bragg (b) Moseley
(c) Laue (d) Miller

865. Neutron was discovered by

(a) Chadwick (b) Thomson
(c) Rutherford (d) Compton

866. The fine structure of Hα line can be explained on the basis of

(a) Rutherford's atom model
(b) Bohr's atom model
(c) Sommerfield's atom model
(d) Thomson's atom model

867. Spin quantum number of an electron can have

(a) only half integral values
(b) only integral values
(c) a constant value equal to 1/2
(d) any integral value

868. In the equation $\mu/p = gh/2mc$, governing the motion of an electron in an atom, 'g' stands for

(a) Bohr magneton
(b) gravitational equivalent of electrostatic forces
(c) Lande's splitting factor
(d) Larmour frequency

869. According to Sommerfield's atom model for the total quantum number $n = 4$, there are

(a) three circular orbits and one elliptical orbit
(b) two circular orbits and two ellipitical orbits
(c) three elliptical orbits and no circular orbit
(d) four elliptical orbits and no circular orbits

870. Cosmic rays are the radiations which come out from

(a) radioactive materials
(b) the core of the earth
(c) Integalactic space
(d) atomic reactors

871. The path of electron moving in a uniform magnetic field perpendicular to its motion is

(a) elliptical (b) circular
(c) hyperbolic (d) parabolic

872. Van Allen Belts are caused by

(a) the altitude effect of cosmic rays
(b) earth's magnetic field effect
(c) the sunspot activity
(d) east-west symmetry

873. X-rays are produced by

(a) accelerating electrons to high speeds
(b) heating a filament to high temperature
(c) discharge of a gas
(d) decelerating fast moving electrons

874. The track of a particle can be seen in a

(a) scintillation counter (b) G. M. counter
(c) Photo-multiplier (d) none of the above

875. The phenomenon of radioactivity is associated with

(a) fusion of nuclei (b) decay of nucleus
(c) decay of protons (d) emission of protons

876. Electrons can be accelerated to very high speeds by a

(a) Klystron (b) Magnetron
(c) Thyratron (d) Cyclotron

877. The decay constant of a radioactive element is independent of the external conditions such as pressure, temperature and electric field

(a) The above statement is correct
(b) The above statement is incorrect
(c) Can't say

878. In a working nuclear reactor, Cadmium rods are used for

(a) speeding up neutrons
(b) speeding up the chain reaction
(c) absorbing some neutrons
(d) absorbing all neutrons

879. When four Hydrogen nuclei combine to form a Helium nuclei

(a) energy is absorbed
(b) mass is increased due to absorption of energy

(c) Beta-particles are emitted
(d) energy is released

880. The source of Sun's energy is
(a) nuclear fission
(b) nuclear fusion
(c) oceans of fossil fuels burning from time immemorial
(d) electrical incandescence

881. An example of nuclear fusion is
(a) the formation of water from hydrogen and oxygen
(b) the formation of Barium and Krypton from Uranium
(c) formation of Helium from Hydrogen
(d) none of the above

882. According to Compton effect, when X ray falls on matter, in addition to the classical scattering there is also secondary radiations containing X-rays of lower frequency. The increase in wave-length between the two
(a) is independent of the wave-length of the incident radiations, nature of scattering substances and angle of scattering
(b) is dependent on the wave-length of the incident radiations, nature of scattering substances and angle of scattering
(c) is independent of the wave-length of the incident radiations, nature of scattering substance but is dependent on the angle of scattering
(d) is dependent on the wave-length of the incident radiation but is independent of the nature of scattering substances and angle of the scattering

883. When a beam of X-ray passes through matter, scattering co-efficient σ is given by $\sigma=\frac{8\pi}{3}\frac{e^4}{m^2c^4}.n$ when n is
(a) no. of protons per unit area
(b) no. of electrons per unit volume
(c) no. of neutrons per unit volume
(d) the atomic weight of the element

884. The spontaneous emission of particles from heavy nuclei and the phenomenon of nuclear fission are evidences of
(a) Stability
(b) Instability
(c) Isomerism
(d) None of the above

885. Paschen Series is obtained when electron jumps from an outer stationary orbit to the
    - (a) First stationary orbit
    - (b) Second stationary orbit
    - (c) Fourth Stationary orbit
    - (d) Third stationary orbit

886. The emission of an electron by an atom without the emission of X or γ radiations, as a result of a change from an excited state to a lower energy state. This phenomenon is
    - (a) Auger Effect
    - (b) Bhor's correspondence principle
    - (c) Ritz's combination principle
    - (d) Isomerism

887. Light is emitted when charged particle pass through a transparent medium at a velocity greater than the velocity of light in that medium. This is called
    - (a) Radiation
    - (b) Cerenkov Radiation
    - (c) Isomerism
    - (d) Optical excitation

888. Atomic nuclei containing the number of neutrons corresponding to the magic number have
    - (a) Total instability
    - (b) Exceptional stability
    - (c) Partial stability
    - (d) Partial instability

889. An electron within an atom is specified by certain quantum numbers. These are
    - (a) Principle quantum number, azimthal quantum number
    - (b) magnetic quantum number
    - (c) magnetic spin quantum number
    - (d) all of the above

890. Nuclear isomers are
    - (a) atoms of an element of different mass but possessing same rate of radioactive decay
    - (b) atoms of an element of the same mass but possessing different rate of radioactive decay
    - (c) atoms of an element of the same mass and possessing same rate of radioactive decay
    - (d) inexistant

891. According to Larmor the effect of a uniform magnetic field on the motion of an electron moving in any closed orbit is to impress on the whole system a uniform preccssion about

an axis parallel to the field with an angular velocity (called Larmor precession) given

(a) $w = \frac{2mc}{Be}$ (b) $w = \frac{1}{2}m^2c/Be$

(c) $w = \frac{Be}{2mc}$ (d) $w = \frac{2Be}{mc}$

892. The effect of Larmor precession is to

(a) increase the energy of the atom when excited

(b) increase or decrease the energy of the atom when excited

(c) decrease the energy of the atom when excited

(d) maintain constant energy of the atom when excited.

893. Under weak magnetic field the alkali metals like Na, Li, K show anomolus Zeeman effect. Under strong magnetic field they show normal Zeeman effect. The phenomenon is called

(a) Paschen-back effect (b) Raman effect

(c) Larmor effect (d) Bosan effect

894. The plane of polarisation of light is rotated by reflection at the polished surface of a magnet. This phenomenon is called

(a) Zeeman effect

(b) Compton effect

(c) Magneto-optic Kerr effect

(d) Magneto-optic stark effect

895. Three hypothetical elementary particles with 3 corresponding antiparticles, which have been postulated by Murray-Gall Mann as the basis of all matter are

(a) Nuclear isomers (b) Antimatters

(c) Quartz (d) None of the above

896. The energy of an atom in its least excited state $n=1$ is generally considered to be the energy in the normal condition. This energy is given by

(a) $W_1 = \frac{2\pi^2e^4mz^2}{h^3}$ (b) $W_1 = \frac{2\pi emz^2}{h^2}$

(c) $W_1 = \frac{4\pi^2e^2mz^4}{h}$ (d) $W_1 = \frac{4\pi^2e^4mz^3}{h^2}$

897. The voltage through which an electron has to fall to produce ionization is called ionisation potential of the gas. For Hydrogen it is

(a) 0.2 v (b) 10.5 v
(c) 12.68 v (d) 13.58 v

898. In order of increasing strength of binding force the three binding forces Nuclei atomic and gravitational could be arranged as follows

(a) atomic>nuclear>gravitational
(b) gravitational>nuclear>atomic
(c) Nuclear>atomic>gravitational
(d) Nuclear>gravitational>atomic

899. The ratio of the weight of an atom of Hydrogen to that of an electron is

(a) 18.36 (b) 1836
(c) 18360 (d) 183.6

900. The energy equivalent of 1 electron is approximately

(a) 0.5 MeV (b) 5.2 MeV
(c) 931 MeV (d) 51.1006 MeV

901. The Range 'R' of Alpha particle depends strictly upon the velocity with which they emerge from the source and is proportional to (V = velocity)

(a) $1/v^2$ (b) v^3
(c) $1/v^3$ (d) v^2

902. The ionisation produced by an Alpha parcticle at any point in its track is

(a) directly proportional to its velocity
(b) inversely proportional to Square of the velocity
(c) directly proportional to Square of the velocity
(d) inversely proportional to its velocity

903. Mosley's Law

(a) Predicated the occurrence of two rare earth element Ca and Ti
(b) Removed discrepency in Mendelev periodic table and arranged in order of ascending Atomic Number
(c) Proved Routherford model of atom incorrect
(d) Both (a) and (b)

904. An incident particle striking a target nucleus, leaves without loss of energy and in general with altered direction of motion. This type of reaction is
   (a) Elastic Scattering (b) Inelastic Scattering
   (c) Simple Capture (d) Disintegration

905. Mark the incorrect statement
   (a) The total mass energy in a nuclear recation remains unchanged.
   (b) The total linear momentum of the particles taking part in a nuclear reaction is conserved
   (c) The total angular momentum is conserved
   (d) The total number of nucleus is not conserved

906. The disadvantage of using Neutrons as bombarding agents is
   (a) Neutron carry no charge
   (b) Affected neither by the +ve charge on the nucleus nor by the −ve charges on the extranuclear electrons
   (c) it does not ordinarily loose energy on its passage through the matter
   (d) They have mass equal to that of an electron

907. Neutrons with energies between 1eV and 1.2 MeV are called
   (a) Fast Neutrons (b) Epi-thermal Neutrons
   (c) Slow Neutrons (d) Thermal Neutrons

908. When slow moving neutrons fall on certain substances, they are captured with the emission of a high energy gamma radiation. The new substance formed is
   (a) Stable substance (b) Radioactive
   (c) Antimatter (d) Nuclear Isomer

909. Helium is an inert gas because
   (a) it is formed by the fusion of hydrogen nuclei
   (b) it has a completely filled electronic shell structure
   (c) it is rare gas
   (d) none of the above

910. In Milikan's Oil Drop Experiment,.........has been used
   (a) Graham's law (b) Coulomb's law
   (c) Stokes' law (d) Ampere's law

911. Einstein's photoelectric equation can be verified by
   (a) Milikan's experiment
   (b) Einstein's setup
   (c) Richardson's experiment
   (d) Thomson's experiment

912. A hydrogen atom is in its ground state when its orbital electron ...

(a) is within the nucleus
(b) has escaped the nucleus
(c) is in its highest energy level
(d) is in its lowest energy level

913. For a given total quantum number 'n', the possible number of Sommerfield's elliptical orbits are

(a) one (b) zero
(c) n+1 (d) n

914. The value of Bohr's magneton is given by

(a) $eh/4\pi c$ (b) $eh/4\pi mc$
(c) $h/4\pi m$ (d) $h/4\pi mc$

915. In a fusion process, a proton and neutron combine to form a deuterium nucleus. If m_o and m_p be the masses of the neutron and proton resp., the mass of the deuterium nucleus is

(a) equal to m_o+m_p
(b) more than m_o+m_p
(c) less than m_o+m_p
(d) can be less or more than m_o+m_p

916. In an atom, the size of the nucleus is about 10^{-15} m. and the size of the atom is about 10^{-10} m. Then, the space between the atom boundary and the nucleus is occupied by

(a) air at N.T.P.
(b) vacuum
(c) electrons in constant motion
(d) none of the above

917. Alpha, Beta and Gamma radiations come out of a substance of radioactive nature

(a) when it is excited by supplying heat energy
(b) when it is put in an atomic reactor
(c) spontaneously
(d) by applying large electrostatic potentials

918. The decay constant of the end product of all the radioactive series is

(a) zero
(b) half the value of the decay constant of the first element in that series
(c) infinity
(d) cannot be said with surety

919. The function of a moderator in an atomic reactor is to

(a) absorb the dangerous gamma radiations
(b) react with Uranium to release energy
(c) slow down fast neutrons to increase the fission probability
(d) provide extra neutrons to sustain the fission process

920. The Compton effect in X-rays proves that

(a) the electron has wave property
(b) the X-rays have wave properties
(c) the X-rays have particle characteristics
(d) none of the above.

921. An atom consists of a tiny, massive and charged nucleus. It was first concluded from

(a) the experiments on X-ray diffraction
(b) the Laue's spots
(c) the experiment that some alpha particles are deflected through large angles by matter
(d) the polarisability of an atom

922. Tick one among the following which will not produce a track of condensed vapour in a Cloud Chamber

(a) Electron (b) proton
(c) positron (d) neutron

923. An electron microscope employs which one of the following principles

(a) Electrons have a wave nature
(b) Electrons can be focussed by an electric field
(c) Electrons can be focussed by a magnetic field
(d) all of the above

924. In an electron microscope, as the concentration of the electron beam striking the object increases, the perceptibility

(a) decreases
(b) increases
(c) remains unaffected
(d) first increases, levels off and then decreases exponentially

925. Which of the following series of hydrogen falls in the infrared region

(a) Layman (b) Balmer
(b) Brackett (d) none of the above

926. In Bohr's atom model, the lowest orbit corresponds to

(a) the maximum energy
(b) the minimum energy
(c) zero energy
(d) infinite energy

927. According to Bohr's theory, the outer orbits have greater energy than the inner ones.

(a) correct
(b) incorrect
(c) all the orbits have equal energy

928. The concept of nuclear atom was established from

(a) scattering of alpha particles by Gold foil
(b) emmission of electrons from metal surfaces.
(c) bright line spectra of hydrogen atom
(d) diffraction of X-rays by crystals.

929. Isotopes have the same

(a) mass number
(b) atomic number
(c) mass and atomic number
(d) Avogadro's number

930. In the Bohr model of the atom, the electron does not fall into the nucleus because

(a) the quantum rules do not allow it
(b) the electrostatic attraction is balanced by mechanical forces
(c) the electron is not a particle
(d) the space between the nucleus and the atom boundary is filled with ether

931. Which of the following quantities will be zero for alpha particles at the point of closest approach to the Gold nucleus, in Rutherford's experiment

(a) acceleration (b) kinetic energy
(c) potential energy (d) electrical energy

932. The fact that the photon carries momentum was established by
(a) the Bohr's theory of the atom
(b) the J.J. Thomson's experiment
(c) the Compton effect
(d) the Doppler's effect

933. X-rays are
(a) streams of negatively charged particles
(b) streams of positively charged particles
(c) electromagnetic waves
(d) none of the above

934. Which of the following is electromagnetic in nature
(a) alpha rays (b) beta rays
(c) gamma rays (d) cathode rays

7

ELECTRONICS

935. In a crystal controlled oscillator, the crystal takes the place of the
(a) vacuum tube (b) transistor
(c) FET (d) Tank-circuit

936. Which one of the following is a semiconductor.
(a) copper (b) ebonite
(c) germanium (d) wood

937. Which one of the following is a semiconductor
(a) aluminium (b) indium
(c) silicon (d) copper

938. Holes can exist in
(a) insulators (b) conductors
(c) semiconductors (d) all of the above

939. The forbidden energy gap of germanium at 0°K is
(a) 0.72 eV (b) 7.2 eV
(c) 0.01 eV (d) 1.10 eV

940. In Hall effect, the current carriers are drifted towards the direction of
(a) the magnetic field
(b) current

(c) sides perpendicular to both magnetic field and current

(d) cannot be said

941. If Silicon has to be doped by an acceptor impurity, the dopent should be

(a) tetravalent
(b) trivalent
(c) pentavalent
(d) hexavalent

942. The free electrons in **a** metal are not able to leave it as and when they please, because a potential hill or barrier exists at the surface of the metal

a) it is an incorrect statement
(b) it is a correct statement
(c) can't be said

943. Fermi energy is

(a) the minimum energy possessed by an electron at 0°K
(b) the maximum energy possessed by an electron at 273°K
(c) the maximum energy possessed by anye lectron at 0°K
(d) the minimum energy possessed by any electron at 273°K

944. The work function of a metal represents the

(a) the maximum amount of energy to be given to the slowest electron at the absolute zero to allow it to escape the metal
(b) the work done in moving an electron from infinity to the metal surface
(c) the work done in moving an electron on an equipotential line in an electric field
(d) the minimum amount of energy that must be given to the fastest moving electron at the absolute zero so as to enable it to escape.

945. According to Richardson's Thermionic emission equation, the thermionic current

(a) is directly proportional to 'T'
(b) is inversely proportional to 'T'
(c) is directly proportional to T^2
(d) is inversely proportional to T^2

946. The thermionic current increases as
   - (a) the area of the filament is decreased
   - (b) the area of the filament is increased
   - (c) the temperature is decreased
   - (d) the work function is increased

947. The practical result of Schottky effect is that it
   - (a) increases the barrier height at the metal surface
   - (b) decreases the barrier height at the metal surface
   - (d) holds the barrier steady at the metal surface
   - (d) none of the above

948. The secondary emission of electrons is dependent upon
   - (a) the energy of the primary electrons
   - (b) the number of the primary electrons
   - (c) the angle of incidence of the electrons on the metal
   - (d) all of the above

949. To obtain copious emission of electrons at moderately low temperatures, which of the following materials can be used
   - (a) Cesium (b) Rubidium
   - (c) Barium (d) Thoriated Tungsten

950. The limitation to the use of Thoriated Tungsten emitters is
   - (a) deactivation due to negative ion bombardment
   - (b) the temprature of operation of the tube
   - (c) deactivation due to positive ion bombardment
   - (d) they cannot be used at low voltages

951. Which of the following material would you use for a high-vacuum, high voltage tube
   - (a) Thoriated Tungsten (b) Tungsten
   - (c) Copper (d) Cesium

952. Which one of the following is not an advantage of an oxide-coated cathode
   - (a) It has a long life of several thousand hours
   - (b) It gives tremendous outputs at pulsed operations
   - (c) It has a high cathode efficiency
   - (d) It can be used with very high voltages

953. In a diode, the velocity of electrons is maximum
   - (a) near the cathode
   - (b) near the anode
   - (c) in the space in between the two electrodes
   - (d) it is same throughout the tube

954. The charge density of electrons in a diode
    (a) is maximum near the cathode
    (b) is minimum near the cathode
    (c) is maximum near the anode
    (d) is same throughout the space inside the tube

955. According to Langmuir-Child law the plate current
    (a) varies as the cube of the plate potential
    (b) varies as the three-halves of the plate current
    (c) varies as the square of the plate potential
    (d) varies as the three-quarters of the plate potential

956. The space charge current
    (a) depends upon the temprature of the cathode
    (b) depends upon the work function of the cathode material
    (c) is independent of the work function of the material of the cathode
    (d) is independent of the geometry of the tube.

957. Which one of the following factors influences the space charge current in a tube
    (a) Filament voltage drop
    (b) contact potential
    (c) initial velocities of the emitted electrons
    (d) all of the above

958. Thermionic emission in a tube determines the value of the
    (a) space charge limited current
    (b) temperature saturated value of the current
    (c) voltage saturated value of the current
    (d) don't know

959. Which one of the following is not a characteristic of an ideal diode
    (a) forward resistance zero
    (b) reverse resistance zero
    (c) the capacitance shunting the diode is zero
    (d) the characteristics are independent of temperature

960. For small signal operation of a diode, the dynamic plate-resistance is given by
    (a) $r_p = dI_p/dV_p$ (b) $r_p = dV_p.dI_p$
    (c) $r_p = dV_p/dI_p$ (d) none of the above

961. A diode can be used for making
    (a) an amplifier (b) an oscillator
    (c) a rectifier (d) nothing

962. Which one of the following is not an element of a triode.

(a) anode (b) cathode
(c) control grid (d) suppresser grid

963. Plate characteristics of a triode are plotted between

(a) plate current and grid current
(b) plate voltage and grid current
(c) plate voltage and plate current
(d) grid voltage and plate voltage

964. Which one of the following is called mutual characteristics of a triode

(a) graph between plate current and plate voltage
(b) graph between plate current and grid voltage
(c) graph between plate voltage and grid voltage
(d) graph between grid current and grid voltage

965. Transfer characteristics of a tube are the graph between

(a) plate current and plate voltage
(b) grid current and grid voltage
(c) plate current and grid voltage
(d) plate voltage and grid voltage

966. The interrelationship between [the plate resistance r_p, the mutual conductance g_m and the amplification factor 'μ' of a tube is given by

(a) $g_m=\mu.r_p$ (b) $r_p= \cdot g_m$
(c) $\mu=g_m.r_p$ (d) $\mu=g_m/r_p$

967. The amplification factor of a triode is given by

(a) dV_p/dI_p (b) dV_p/dV_g
(c) $-dV_p/dV_g$ (d) dI_p/dV_g

968. A diode can be used as

(a) an amplifier
(b) an oscillator
(c) an LC coupled amplifier
(d) a detector

969. The diode cannot be used as

(a) a rectifier (b) a detector
(c) modulator (d) amplifier

970. The primary source of electrons in vacuum tube is

(a) secondary electrons
(b) schottky electrons
(c) photoelectric electrons
(d) thermionic emission

971. An oxide-coated filament is used in vacuum tubes because
(a) it has a longer life
(b) it can withstand high voltages
(c) it emits electrons at low temperatures
(d) it reduces the effect of space charge

972. Three amplifier stages each with a gain of 30 are cascaded. The overall gain is
(a) 30 (b) 90
(c) 270 (d) 27,000

973. A capacitor-resistor combination as used in oscillators in the grid circuit to
(a) generate oscillations
(b) bias the grid automatically
(c) to amplify the oscillations
(d) to sustain the oscillations

974. The greatest influence on electron flow in a triode is exerted by
(a) the supply voltage (b) cathode
(c) anode (d) grid

975. When a triode is used as a class A amplifier, the grid bias should correspond to
(a) the straight line portion of the $V_g - I_p$ graph
(b) the upper bend
(c) the lower bend (d) the cut-off grid voltage

976. A positive signal applied to the grid of a triode results in
(a) the increase of plate current and plate voltage
(b) the decrease of plate current and increase of plate voltage.
(c) the decrease of plate current and plate voltage.
(d) the decrease of plate current and decrease of plate voltage

977. The D.C. resistance of a tube is......the A.C. resistance
(a) more than (b) less than
(c) equal to

978. Thermionic valves are evacuated because
(a) a lot of heat is produced due to the ionisation of the air
(b) the electrons free path is reduced in an atmosphere
(c) electrons cannot be produced from the neutral atoms of the air
(d) to avoid unnecessary noise

979. Which one of the following is not a disadvantage of electrolytic capacitors
    - (a) they are polarised (b) they dry out
    - (c) they can be used with DC only
    - (d) they are small in size

980. Does a capacitor have any inductance?
    - (a) Yes (b) No
    - (c) cannot be said with surety, it might have

981. Does an inductance have any capacitance?
    - (a) Yes (b) No
    - (c) cannot be said with surety, it might have.

982. Does a resistor have any inductance or capacitance
    - (a) inductance only (b) capacitance only
    - (c) both inductance and capacitance
    - (d) neither inductance nor capacitance

983. An LC circuit has the resonant frequency of 5,000. Hz. What shall be the resonant frequency if the LC product is increased 25 times
    - (a) 1,25,000 Hz (b) 1000 Hz
    - (c) 25,000 Hz (d) 5,000 Hz

984. A coil has a 'Q' of 2,000 at a frequency of 1 MHz. What shall be the Q of the coil at 10 MHz
    - (a) less than 2,000 (b) more than 2,000
    - (c) 2,000 only

985. Which of the following vacuum tube elements gives off electrons.
    - (a) anode (b) grid
    - (c) cathode (d) suppresser grid

986. Does a high gain vacuum tube have a high or low g_m
    - (a) low g_m (b) high g_m
    - (c) g_m is unrelated to amplification
    - (d) cannot be said

987. How is the amplification factor affected in a triode if the grid is moved closer to the cathode
    - (a) decreases (b) increases
    - (c) remains unaffected

988. How is amplification factor affected in triode if the grid wires are spaced wider
    - (a) decreases (b) increases
    - (c) remains unaffected

989. What is the efficiency of a triode if the dc input power is 200 W and the output is 140 W

(a) 39%
(b) 70%
(c) 30%
(d) 65%

990. Under what condition does a vacuum tube supply maximum power output to a load

(a) $Z_1 = r_p$
(b) $Z_1 < r_p$
(c) $Z_1 > r_p$

991. The advantage of class A operation of an amplifier is

(a) high efficiency
(b) high gain
(c) low distortion

992. The advantage of class C operation of an amplifier is

(a) high efficiency
(b) low distortion
(c) high distortion

993. Which of the following mode of operation of an amplifier is analogous to the operation of a rectifier

(a) class A
(b) class B
(c) class C
(d) class AB

994. What makes Schottky diodes high speed diodes

(a) abundance of minority carriers
(b) abundance of majority carriers
(c) no minority carriers
(dl no majority carriers

995. The P material of a diode is having a.........polarity

(a) positive
(b) negative
(c) neutral

996. Dynamic transfer characteristic of a triode can be used to

(a) find the output waveform for any given input waveform
(b) find the space charge in the tube
(c) calculate the efficiency of the tube
(d) none of the above

997. The forbidden energy gap of silicon at 0° K is

(a) 0.72 eV
(b) 7.2 eV
(c) 1.1 eV
(d) 11 eV

998. Hole is a......carrier

(a) negative charge
(b) positive charge
(c) neutral

999. Holes move in the direction
   (a) of flow of current
   (b) of flow of conventional current
   (c) opposite to that of the conventional current flow
   (d) cannot be said

1000. The conductivity of germanium or silicon will......with temperature
   (a) decrease (b) increase
   (c) remain same

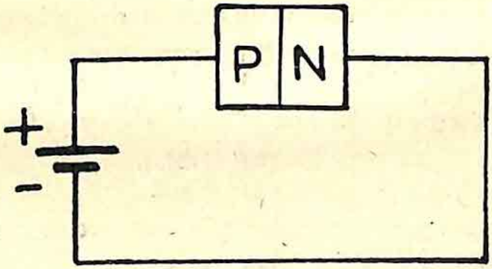
1001. Mass action law in a semiconductor is given by
   (a) $n=n_i^2$ (b) $n.p.=n_i^2$
   (c) $n/p=n_i^2$ (d) $p/n=n_i^2$

1002. Which one of the following is not a donor atom
   (a) phosphorus (b) antimony
   (c) arsenic (d) aluminium

1003. Which one of the following is not an acceptor impurity
   (a) boron (b) gallium
   (c) indium (d) arsenic

1004. The thickness of the depletion region is of the order of
   (a) 10^{-4} cm (b) 10^{-5} cm
   (c) 10^{-6} cm (d) 10^{-7} cm

1005. What is the bias direction of the circuit shown in the diagram

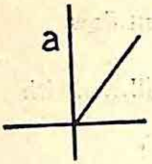


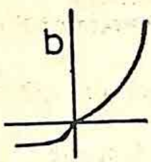
   (a) reverse (b) forward
   (c) don't know

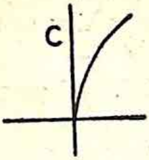
1006. The cutin voltage of a silicon diode is
   (a) 1.1 V (b) 0.72 V
   (c) 0.6 V (d) 6.0 V

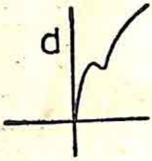
1007. The cutin voltage of a germanium diode is
   (a) 1.1 V (b) 0.72 V
   (c) 0.6 V (d) 0.2 V

1008. Which one of the following is the ideal diode characteristic









1009. In the active region operation of a transistor
(a) the collector and emitter junctions are forward biased
(b) the collector and emitter junctions are reverse biased
(c) the collector junction is forward biased and the emitter junction is reverse biased
(d) the collector junction is reverse biased and the emitter junction is forward biased

1010. When the emitter and collector junctions both of a transistor are reverse biased, it is said to be operating in the
(a) active region (b) cut-off region
(c) saturation region (d) none of the above

1011. If both the collector and emitter junctions of a transistor are forward biased, the transistor is said to operate in the
(a) active region (b) saturation region
(d) cut-off region (d) none of the above

1012. An oscillator is basically an amplifier with loop gain
(a) less than unity (b) more than unity
(c) zero (d) none of the above

1013. Ripple factor in the case of a half wave rectifier is equal to
(a) 1.1 (b) 1.21
(c) 0.482 (d) 1.482

1014. Ripple factor in the case of full wave rectifier is equal, to
(a) 1.1 (b) 1.21
(c) 0.482 (d) 1.482

1015. If a full wave rectifier contains a transformer with a potential of 20 V from the mid points to the either end, the maximum peak inverse voltage possible is
(a) 80 V (b) 20 V
(c) 40 V (d) 16 V

Appendices

MECHANICS

Mechanics

The branch of physical science dealing with the behaviour or matter under the action of force.

Unit

A quantity or dimension adopted as a standard of measurement.

Dimension

The dimensions of a physical quantity are the powers to which the fundamental units expressing that quantity are raised.

Couple

When two equal, opposite, parallel and non-collinear forces act on body bringing about rotation, they are said to constitute a couple. The turning moment of a couple is given by

Moment of couple = One of the forces × Arm of the couple.

Torque

Moment of the couple is called the torque.

Centrifugal force

The outward force acting on a body rotating in a circle round a central point.

Centripetal force

The centripetal force is the radial force imposed by the constraining system, necessary to keep the body moving in its circular path.

Projectile

A body which is thrown or projected. If the projectile is discharged with a velocity 'v' at an angle 'a' to the horizontal, the following formulae hold true if the resistance of the air is neglected.

Time to reach highest point of flight $= v \, \mathrm{Sin} \, a/g$
Total time of flight $= 2v \, \mathrm{Sin} \, a/g$
Maximum height $= v^2 \, \mathrm{Sin}^2 \, a/2g$
Horizontal range $= v^2 \sin 2a/g$

Inertia

The tendency of body to preserve its state of rest or of uniform motion in a straight line.

Inertial mass

The mass of a body as determined by its momentum, as opposed to 'gravitational mass' which is determined by the extent to which it responds to the force of gravity.

Inertial system

A frame of reference in which bodies are not accelerated, i.e., remain at rest or move with constant velocity, unless acted upon by external forces. Newtonian mechanics is valid in such a system.

Moment of Inertia

The moment of inertia I of a body about any axis is the sum of the products of the mass d_M of each element of the body and the square of 'r', the distance from the axis.

Radius of gyration

The effective distance of the particles of a body from its axis of rotation is called its radius of gyration about that axis and is equal to the root mean square distance of the particles from the axis.

Gyroscope

A spinning wheel which is mounted in such a way that it is free to rotate in any axis; i.e., universally mounted. Such a wheel has two properties upon which the applications of the gyroscope depend, viz; 1. rigidity in space (gyroscopic inertia); the support of the wheel may be turned in any direction without altering the direction of the wheel with respect to the space. 2. Precession: When a gyroscope is subjected to a force tending to alter the direction of the axis, the wheel will turn about an axis at right angles to the axis about which the force was applied.

Simple Pendulum

A device consisting of a weight or 'bob' swinging on the end of a string or wire. In the case of an ideal pendulum, when the angle described by the pendulum is small, the string has negligible weight, and the mass of the pendulum is concentrated at one point, the time of one complete swing, T, is given by $2\pi\sqrt{l/g}$ where 'l' is the length of the string and 'g' the acceleration due to gravity.

Compound Pendulum

It is just a rigid body capable of oscillating freely about a horizontal axis, passing through it.

Acceleration due to gravity

The acceleration of a body falling freely in a vacuum; varies slightly in different localities as a result of variations in the distance from the centre of mass of the earth.

Newton's law of Gravitation

Every particle in the universe attracts every other particle with a force which is directly proportional to the product of the masses of the particles and inversely proportional to the square of the distance between them. Thus the force of attraction between two masses m_1 and m_2 in kilograms seperated by a distance of 's' metres, is give by

$$F=G\ m_1m_2/s^2 \text{ newtons,}$$

where G is the gravitation constant.

Kepler's Laws

The following are the three laws formulated by Kepler

i) The path of a planet is an elliptical orbit, with the Sun at one of its foci. This is also known as the law of elliptical orbits.

ii) The radius vector, drawn from the Sun to a planet sweeps out equal areas in equal time i.e., its areal velocity is constant. This is called as the law of areas.

iii) The square of a planet's year is proportional to the cube of the semi-major axis of its orbit. This is know as the Harmonic law.

Escape velocity

The velocity which a projectile or space probe would need to attain in order to escape from a particular gravitational field. It depends upon the planet's mass and diameter.

Elasticity

The property of a body or material of resuming its original form and dimensions when the forces acting upon it are removed. If the forces are sufficiently large for the deformation to cause a break in the molecular structure of the body or material, it loses its elasticity and the elastic limit is said to have been reached.

Elastic Limit

The limit of stress within which the strain in a material completely disappears when the stress is removed.

Hooke's Law

Provided the strain is small, the stress is proportional to the strain; so that, in such a case, the ratio stress/strain is a constant called the modulus of elasticity or the coeff. of elasticity.

Young's Modulus

Elastic modulus applied to a stretched wire or to a rod under tension of compression, the ratio of the stress on a cross-section of the wire or rod to the longitudinal strain.

Bulk modulus

Elastic modulus applied to a body having uniform stress distributed over the whole of its surface. Its value is given by the expression pv/V.

Rigidity modulus

Elastic modulus applied to a body under a shearing strain.

Resilience

The capacity of an elastic body to resist a blow or a mechanical shock without acquiring a permanent set.

Orbital velocity

The velocity of a satellite or space craft which enables it to orbit round the earth of other celestial bodies.

Streamline

A streamline is line in a fluid such that the tangent to it at every point is in the direction of the velocity of the fluid particle at that point, at the instant under consideration. When the motion of the fluid is such that, at any instant, continuous streamlines can be drawn through the whole length of its course, the fluid is said to be in streamline flow.

Bernoulli's Theorem

At any point in a tube through which a liquid is flowing, the sum of pressure energy, potential energy and the kinetic energy is constant.

Viscosity

The property of a fluid wherby it tends to resist relative motion within itself. If different layers of fluid are moving with different velocities, viscous forces come into play, tending to slow down the faster moving layers and to increase the velocity of the slower moving layers. For two parrallel layers in the direction of flow, a short distance apart, this viscous force is proportional to the velocity gradient between the layers. This constant of proportionality is called the coeff. of viscosity of the liquid.

Reynold's number

A dimensionless quantity applied to a liquid flowing through a cylindrical tube.

Surface Tension

An open surface of a liquid is under a state of tension causing a tendency for the portions of the surface to separate from each other; the surface thus shows properties similar to those of a stretched elastic film over the liquid.

THERMAL PHYSICS

Heat

Energy possessed by a substance in the form of kinetic energy of atomic or molecular translation, rotation, or vibration. The heat contained by a body is the product of its mass, its temperature and its specific heat; it is expressed in joules (SI units), calories (c.g.s units) or British thermal units in f.p.s units. Heat is transmitted by conduction, convection and radiation. The chief observable physical effects of a change in the heat content of a body could be rise in temperature, change from solid to a liquid state (melting), solid to gas (sublimation) and liquid to gas (evaporation & boiling); expansion; and electrical effect such as the Peltier and Seebeck effect.

Heat capacity

When the temperature of a system is increased by an amount dT as a cosequence of the addition of a small quantity of heat dQ, the quantity dQ/dT is termed the heat capacity

Temperature

The temperature of a body is a measure of its hotness; which can be defined as a property determining the rate at which heat will be transferred to or from it. Temperature is thus a measure of the kinetic energy of the molecules, atoms or ions of which matter is composed.

Temperature measured on a scale in which melting point of ice is 0° and boiling point is 100° is called the CELSIUS temperature. In FAHRENHEIT scale 0° corresponds to 32° and 100° corresponds to 212° respectively. In REAUMER scale lower and upper limits are fixed at 0° and 80° respectively

$$C/5=(F-32)/9=R/4$$

In mercury in glass scale of temperature the thermal expansion of mercury is utilised in defining and measuring temperature

$$t=((l_t-l_0)\times 100/(l_{100}-l_0))°C$$

In constant volume Hydrogen scale of temperature the variation of pressure with temperature at constant volume is utilised

$$t=((P_t-P_0)\times 100/(P_{100}-P_0))°C$$

Resistance of platinum changes with temperature. This prinicipIe is utilised in Platinum resistance thermometer.

$$t=((R_t-Ro)\times 100/(R_{100}-R_0))°C$$

Absolute Thermodynamic Temperature

Absolute thermodynamic temperature is a basic physical quantity, which depends on the concept of temperature as a measure of the thermal energy of random motion of the particles of a system in thermal equilibrium. Thermodynamic temperature is defined using only one fixed point, the triple point of water, which is fixed at 273.16 Kelvin. The magnitude of the unit of thermodynamic temperature, the Kelvin and Centigrade temperature interval are identical. The relation between the Kelvin temperature (T) and the celsius temperature (t) is given by $T=t+273.16$

Co-Efficient of Expansion of Solids

Increase in the length per unit length per degree centigrade rise in temperature is called the co-efficient of linear expansion (α). Co-efficient of superficial expansion (β) is defined as the increase in area per unit area per degree rise in temperature. Co-efficient of cubical expansion (γ) is defined as the increase in volume per unit volume per degree centigrade rise in temperature. The co-efficient of expansions are related to each other by

$$\alpha : \beta : \gamma :: 1 : 2 : 3$$

Co-Efficient of Expansion of Liquids

Expansion of liquid is affected by the expansion of the vessel containing it. Thus we have apparent expansion and real expansion of liquid. Liquid can have only Volume expansion. Co-efficient of apparent expansion (γ_a) is the increase in volume per unit volume per degree rise in temperature including the expansion of the vessel containing it. Co-efficient of real expansion (γ_r) is the volume expansion of the liquid independent of the expansion ofthe containing vessel.

$$\gamma_r = \gamma_a + \gamma_g$$

Where γ_g is the co-efficient of volume expansion of the containing vessel.

Expansion of gases

Increase in pressure of a fixed mass of a gas at constant volume per degree centigrade rise in temperature to its original pressure at 0°C is the pressure co-efficient of a gas

$$P_t = P_0(1 + \gamma_{pt})$$

Increase in volume of a given mass of gas per degree centigrade rise in temperature, at constant pressure to its original volume at 0°C is the volume co-efficient of gas

$$V_t = V_0(+\gamma_{rt})$$

For perfect gas pressure co-efficient and volume co-efficient are both equal to 1/273 per degree centigrade. For a perfect gas

$$PV/T = \text{constant} = R$$

R is called the gas constant and its value is equal to 8.3×10^7 ergs/gm-mol/A

Specific heat of a gas

The specific heat of a gas at constant volume (C_v) is the amount of heat required to raise the temperature of 1 gm of the gas through 1°C keeping the volume constant.

The specific heat at constant pressure of a gas (C_p) is the amount of heat required to raise the temperature of 1 gm of the gas through 1°C keeping the pressure constant

The specific heat at constant pressure is greater than the specific heat at constant volume by an amount which is the thermal equivalent of the work done in expanding the gas against external pressure.

$C_p - C_v = R/J$, R is the universal gas constant if C_p and C_v are measured in units of work then $C_p - C_v = R$. If c_p and c_v denote the two specific heats of the gas per gram per degree centigrade and r is the gas constant for one gram of the gas then

$$c_p - c_v = r/J$$

The ratio of the two specific heat $c_p/c_v = \gamma$ has the value 1.67 for monoatomic gases and for diatomic gases it is 1.40.

Atomic Heat

The product of atomic weight and specific heat of a solid is constant. Dulong and Petit's law states that the atomic heat of all solids is approximately 6.4 calories per mole per degree. The law is obeyed by many elements at ordinary temperatures, but at lower temperature the atomic heat of all elements falls below this value, tending to zero as the absolute zero of temperature is approached. Specific heat of a solid increases with rise in temperature and tends to zero as the absolute zero of temperature is approached. Specific heat of liquids also increases with rise in temperature.

Latent Heat

The quantity of heat absorbed or released in an isothermal transformation of phase is termed Latent heat. The specific latent heat of fusion is the heat required to convert unit mass of a solid to a liquid at the same temperature. The specific latent heat of vapourisation is the heat required to convert unit mass of liquid to vapour at the same temperature. At the melting and boiling points of a substance, the addition of heat causes no rise in temperature until the change of state is completed.

Kinetic Theory of Gases

A mathematical explanation of the behaviour of gases on the assumption that gases consists of molecules which are in ceaseless motion in space, the kinetic energy of the molecules depending upon the temperature of the gas; the molecules are considered to be perfectly elastic particles which collides with each other and with the walls of the containing vessel. The pressure exerted by a gas on the walls of the vessel is due to the collisions of the molecules with it. The gas laws are in full agreement with this theory.

(a) C the root mean square velocity of the molecules and is equal to the square root of the mean of the squares of the velocities of the various molecules

$$C^2=\frac{c_1^2+c_2^2+c_3^2+\dots\dots+c^2n}{n}$$

(b) Pressure of a gas $P=\rho\, c^2/3$ where ρ is the density of the gas

$\rho=M/V$
M = total mass of the gas = mn
V = Volume of the gas
n = number of molecules
m = mass per molecule

$P=\rho\, c^2/3=2E/3$, E = mean kinetic energy per unit volume of the gas

(c) Kinetic energy per gram molecule of any gas at the absolute temperature $T=3RT/2$; Kinetic energy per molecule $(3/2)\times(R/N)\times T=3KT/2$

(d) Avogadro's hypothesis—equal volumes of two gases at the same temperature and pressure have the same number of molecules.

(e) Dalton's law of partial pressures—The total pressure of a mixture of two or more gases or vapours is equal to the sum of the pressure that each component would exert if it were present alone, and occupied the same volume as the whole mixture.

(f) The absolute zero temperature is that temperature at which the linear velocities of the molecules of a gas are reduced to zero.

(g) The mean kinetic energy per molecule in a given mass of a gas is proportional to the absolute temperature.

Mean Free Path

The average or mean distance travelled by a particle, atom, or molecule between collisions. In a gas the mean free path between molecules is inversely proportional to the pressure. The average or mean time that elapses between two collisions of a particle, atom or molecule is Mean free time. Mean free path is inversely proportional to the density. But the density of a gas varies directly as the pressure and inversely as the absolute temperature. Therefore the mean free path is inversely proportional to pressure and directly proportional to the absolute temperature.

Degree of Freedom

The least number of independent variables defining the state of a system which must be given before this state is completely determined is called the degree of freedom.

Law of Equipartition of Energy

For any dynamical system in thermal equilibrium the total energy is divided equally among all the degrees of freedom and energy associated with one molecule per degree of freedom $= KT/2$

Critical State

The state of a substance when its liquid and gaseous phases have the same density, at the same temperature

The temperature above which the gas cannot be liquified by pressure alone is the *critical temperature.*

The pressure of its saturated vapour of a substance at the critical temperature is called the *critical pressure.*

The volume occupied by unit mass of a substance at its critical temperature and critical pressure is called the *critical volume.*

Van Der Waals Equation of State

$$(p + a/v^2) \times (V - b) = RT$$

for a mole of a substance in the gaseous and liquid phase where p = pressure; V = volume; T = absolute temperature; R = the gas constant; a/v^2 is a correction for the mutual attraction of the molecules, and b is a correction for the actual volume of the molecules themselves. The equation represents the behaviour of ordinary gases more correctly than the perfect gas equation $PV = RT$.

An attraction force existing between atoms or molecules of all substances is called the Van der waals force. The force arises as a result of electrons in neighbouring atoms or molecules moving in sympathy with one another. This force is responsible for the term a/V^2 in the Van der waals equation of state. This force is small compared with the other inter-atomic attraction and repelsive forces present in many substances.

From Van der waal's equation critical constants are

critical volume$=3b$
critical pressure$=a/27b^2$
critical temperature$=8a/27Rb$

Isothermal Change

When a change in pressure and volume of a substanace takes place but the temperature remains constant, the change is said to be isothermal. $PV=$CONSTANT

Adiabatic Change

When a change in pressure and volume of a substance takes place without the addition or removal of heat from the substance, the change is said to adiabatic. Under adiabatic change.

$PV^{\gamma}=$CONSTANT γ is the ratio of the two specific heat.

For perfect gas $PV=RT$

Therefore $TV^{\gamma-1}=$CONSTANT

Work done under isothermal expansion$=RT\log_e(V_2/V_1)$

Work done during adiabatic expansion$=\frac{R}{(\gamma-1)}\times(T_1-T_2)$

Joule-Thomson Effect

The cooling produced when a gas is allowed to expand through a narrow orifice is called Joule-Thomson effect.

The temperature at which Joule-Thomson effect changes sign is called the temperature of inversion and is given by

$T_i=2a/Rb$, where a, b & R have their usual meaning.

Laws of Thermodynamics.

Zeroth Law

If two bodies are each equal in temperature to a third body they are equal in temperature to each other. This principle of thermal equilibrium is often called the zeroth law of thermodynamic.

First Law

Whenever work is transformed into heat or heat into work, the quantity of work is mechanically equivalent to the quantity of heat

$W\propto H$ or $W=JH$ where J is called Joule's mechanical equivalent of heat, its value is 4.186×10^7 ergs per calorie.

Corollaries of the first law

(a) There exist a property of a close system such that a change in its value is equal to the difference between the heat supplied and the work done during any change of state.

(b) The internal energy of a closed system remains unchanged if the system is isolated from the surroundings

(c) A perpetual motion machine of the first kind is impossible.

Whenever heat is imparted to a body a part of it is used to increase its internal energy and the rest in doing external work. Thus $Q=U+W$

Second Law

Heat cannot be transferred by any continuous, self sustained process from a cooler body to a hotter body. It follows that it is impossible to construct a system which will operate in a cycle and transfer heat from a cooler to a hotter body without work being done on the system by the surroundings.

Important corollaries of the 2nd law

(a) All reversible engines operating between the same two reservoirs have the same efficiency.

(b) A scale of temperature can be defined which is independent of any particular thermometric substance, and which provides an absolute zero of temperature.

(c) The efficiency of any reversible engine operating between more than two reservoirs must be less than that of a reversible engine operating between two reservoirs which have temperature equal to the highest and lowest temperature of the fluid in the original engine.

Carnot's Cycle

An ideal reversible cycle of operations for the working substance of a heat engine. The four steps in the cycle are (a) isothermal expansion, the substance taking heat and doing work; (b) adiabatic expansion, without heat change, external work done; (c) isothermal compression, heat given out, work done on the substance by external forces; (d) adiabatic compression, no heat change, work done on the substance.

The efficiency of any reversible heat engine depends only on the temperature range through which it works and not on the properties of any material substance. If all the heat is taken up at absolute temperature T_1 and all given out at absolute temperature T_2, the efficiency is given by.

$$(T_1—T_2)/T_1$$

Entropy

Change of entropy ($\triangle s$) is defined as the ratio of the amount of heat taken up ($\triangle Q$) to the absolute temperature (T) at which the heat is absorbed i.e., $\triangle S = \triangle Q/T$. The entropy of a system is a measure of its degree of disorder. The entropy of a system can never decrease in any change; it must either increase (irreversible process) or remain constant (reversible process).

Thermal Conductivity

The transmission of heat from places of higher temperature to places of lower temperature in substance, by the interaction of atoms or molecules possessing greater kinetic energy. The rate at which a given material can conduct heat energy is called the thermal conductivity and is given by

$$Q\ 3 = K.A \frac{(\theta_2—\theta_1).\ t}{d}$$

Where $(\theta_2—\theta_1)/d$ is the temperature gradient, A is the cross sectional area, t is the time required to transmit heat, K is the co-efficient of thermal conducivity

Radiation

The emission of any ray from a source by means of electro magnetic waves.

Black Body

A perfectly black body is one which absorbs totally all the radiations of any wave-length which falls on it. The wave-length of the radiation emitted by it depends only on the temperature and is independent of material of the body.

Laws of Black Body Radiation

(a) Kirchoff's Law

The ratio of emissive power and the absorptive power of all bodies is the same and is equal to the emissive power of a perfectly black body.

(b) Stefan's Law

The total energy emitted in the form of heat radiation per unit time from unit area of a black body is proportiomal to the forth power of absolute temperature

$$E = \propto T^4$$

$\propto$ is called Stefan's constant and is equal to 5.6697×10^{-8} W m^{-2} K^{-4}

(c) Wien's Law

The wave-length corresponding to the maximum energy is inversely proportional to the absolute temperature.

$$\lambda m\ T = \text{CONSTANT}$$

Emissive Power

The total energy emitted per unit area of a substance per second is the emissive power. The total emissive power depends upon the temperature of the body and the nature of the substance. The ratio of the total emissive power of a body to its total emissive power of perfect black body at same temperature is called emissivity. (ϵ).

Absorptive Power

The total energy absorbed per unit area of surface by a body per second is absorptive power. The fraction of the radient energy incident on the surface which is absorbed. The absorptivity is a pure numeric and is equal to the emissivity. Good radiators are good absorbers.

Prevost's Theory of Exchanges

According to this theory all bodies at all temperature radiates heats to the surrounding bodies and also absorbs heat. The temperature of the body remains constant when the amount of heat gained by it equals the amount of heat lost by it. This is the state of temperature equilibrium. This is known as Prevost's theory of exchanges.

Newton's Law of Cooling

The rate of loss of heat to the surrounding by a body is directly proportional to the temperature difference between the body and that of the surroundings.

Solar Constant

The energy which would be received per minute by an area of 1 sq-cm placed at the mean distance of the earth from the sun and at right angles to the incident radiations. Its value is 1.937 calories per square centimeter per minute.

Efficiency of Heat Engine

$$\frac{\text{Heat converted to useful work}}{\text{Total heat supplied}} \times 100\%$$

WAVES AND OSCILLATIONS

Simple Harmonic Motion

A point is said to move in simple harmonic motion when it oscillates along a line about a central point. Acceleration of the point is always directed towards a fixed point in its path and varies as its displacement from the fixed point. Simple pendulum, Motion of liquid in a U-tube, Oscillation of a gas in cylinder, Motion of a body suspended by a spring etc., are examples of Simple harmonic motion. Assuming there is no dissipative forces is at work, the total energy at any instant of the motion of the particle is constant. The differential equation of Simple harmonic motion is

$$\frac{d^2y}{dt^2} + w^2y = 0$$

where $\frac{d^2y}{dt^2}$ = acceleration of the particle

y = displacement

w^2 = constant

Lissajous Figures

The locus of the resultant displacement of a point on which two or more simple harmonic motions are impressed. In the common case, two periodic motions are at right angles and are of the same frequency. The Lissajous figure then becomes, in general, a series of ellipses corresponding to the possible difference of phase between the two motions.

The Simple harmonic motions with

Amplitude	*Phase difference*	*Lissajous figure formed*
unequal	0	—a pair of coincident st-line in 1st & 3rd quadrants
unequal	$\pi/4$	—an oblique ellipse lying in 1st & 3rd quadrants

unequal	$\pi/2$	—symmetrical ellipse with major & minor axes coincide with co-ordinate axes
equal	$\pi/2$	—a circle
unequal	$3\pi/4$	—an oblique ellipse lying in 2nd & 4th quadrants
unequal	[illegible]	—a pair of coincident st-line lying in the 2nd & 4th quadrants

Two Simple harmonic motions with amplitudes unequal and period 1 : 2

Phase difference	*Lissajous figure*
0	—Figure of 8 (along Y-axis)
$\pi/2$	—Parabola with vertex at (a, 0)
π	—Figure of 8 (along Y-axis)

Use of Lissajous Figure in Acoustical determination

(a) Measurement of the ratio between the time-periods of the component vibrations

(b) Comparison of the frequencies of two forks which are nearly in unison with each other

Wave Motion

The propagation of a periodic disturbance carrying energy. At any point along the path of a wave motion, a periodic displacement or vibration about a mean position takes place. The locus of these displacements at any instant is called the wave. The wave motion moves forward a distance equal to its wavelength in the time taken for the displacement at any point to undergo a complete cycle about its mean position.

Wave number $=1/\lambda$ is the number of waves in unit length or the reciprocal of wave-length. The distance between successive points of equal phase of a wave is called the wave-length (λ) & is equal to the velocity of the wave motion divided by its frequency.

Longitudinal Wave

Waves in which the vibrations or displacement takes in the direction of propagation of the wave are called Longitudinal wave. The particles in the wave do not vibrate simultaneously, but there is a progressive change in the phase as we go from one particle to the next. There is always a transfer of energy in the direction a wave travels. Wave-length and velocity of propagation of a wave is related as follows

$v=n\lambda$ where n is the frequency

Transverse Wave

Waves in which the vibration or displacement takes place in a plane at right angles to the direction of propagation of the wave.

Transverse Vibrations of Strings

The fundamental frequency of vibrations of a stretched string fixed at both the ends is given by

$$n=(1/2l)\times\sqrt{T/m}$$

The period of vibration t of this fundamental mode of vibration is given by

$$t=(1/n)=2l\sqrt{m/T}$$

"n" in terms of "ρ" the density of the material of the wire and "D" the diameter of the wire is given by

$$n=(1/Dl)\times\sqrt{T/\pi\rho}$$

Laws of vibration of strings

1st—For a given tension $n\propto 1/l$

2nd - For a string of given length and material $n\propto\sqrt{T}$

3rd—$n\propto 1/\sqrt{m}$ for a string of the same length and subjected to same tension,

Velocity of Sound

An elastic medium is necessary in order that sound waves may be propagated. Sound is a longitudinal wave motion in material media and its velocity depends upon elasticity of the medium and its inertia. Thus velocity of the wave is given by

$V=\sqrt{E/\rho}$ where E is the Bulk modulus of elasticity of the medium and ρ is the density of the medium.

Newton's Formula for the Velocity of Sound

Newton first showed that in a homogeneous medium the velocity of a longitudinal wave is given by $\sqrt{E/\rho}$. He assumed that during compression and rarefaction in a sound wave temperature remains constant and therefore Boyle's law holds good. The equation reduces to

$$V=\sqrt{P/\rho}$$

For air at 0°C $P=76\times 13.6\times 981$ dynes/sq cm and $\rho=0.001293$ gm/c.c. Therefore velocity of sound at $0°C=280$ metres/sec, which is far from experimental result of 332 metres/sec. True explanation was given by Laplace.

Laplace Correction

According to Laplace compression and rarefaction accompanying the passage of sound wave in air causes the temperature not to remain constant. Temperature changes in this case takes place under adiabatic conditions. Thus velocity of sound is given by

$$V=\sqrt{\gamma\ P/\rho}$$

substituting $\gamma=1.41$ for air we obtain $V=332.5$ metres/sec at 0°C

(a) *Effect of amplitude and wave-length*—So long as the amplitude remains small, the velocity of sound is independent of amplitude and wave-length. For longer amplitude sound the wave travel faster.

(b) *Effect of pressure*—The velocity of souud is independent of pressure.

(c) *Effect of density*—The pressure remaining the same, the velocities of sound in the two gases are inversely proportional to the square root of their densities, provided γ has the same value for both of them.

(d) *Effect of temperature*—Velocity of sound is directly proportional to the square root of absolute temperature. Increase is about 0.61 m/sec for each degree centigrade rise in temperature.

(e) *Effect of moisture*—Since the density of moist air is less than that for the dry air sound travels faster in moist air than in dry air.

Velocity of sound in solids—is given by the formula $V=\sqrt{v/\rho}$ where v is Young's modulus for solids. In liquid $V=\sqrt{K/\rho}$ where K is Bulk modulus of liquid.

Superposition of Waves (Interference)

The phenomenon of redistribution of energy when two sound waves travelling along the same straight line in a medium, interact is termed interference.

Beats—When two wave trains of nearly the same frequency are sounded simultaneously, a periodic increase and decrease in loudness is heard. This periodic increase and decrease in loudness is termed beats. Caused by interference of sound waves, the number of beats produced per second is equal to the difference in frequencies of the two notes.

ECHO—The effect produced when sound or other radiation is reflected on meeting a solid obstacle or a reflecting medium.

Stationary Waves

A wave produced by the simultaneous transmission of two similar wave motion in opposite directions. Standing waves or stationary waves are caused by interference between waves of the same frequency in such a way that the combined intensity varies between maxima and minima over the region of interference. There are two types of stationary waves (a) Transverse stationary vibrations in which the component waves are transverse and (b) Longitudinal stationary vibrations in which the components are longitudinal. The total energy per wave-length in stationary wave is double that in progressive wave and there is no flow of energy in the case of stationary waves. The ratio of the kinetic to the potential energy is the same at every point at any instant where as in progressive wave half the energy is at any moment kinetic and the other half potential.

Resonance

The vibratory motion produced in a body by the influence of another body when their time periods are exactly equal.

Loudness

The magnitude of the physiological response of the ear to sound. As the ear responds differently to different frequencies, the loudness of a sound will depend to a certain extent on its frequency. However, loudness can be roughly correlated with the cube root of the intensity of sound, and different levels can be conveniently compared by the units decibel and phon.

Quality of Sound

Most sounds are not 'pure' as they are composed of vibrations of more than one frequency. A note consists of a 'fundamental' and several overtones, of much lesser intensity and of frequencies which are simple multiples of that of the fundamental. The various overtones produced a characteristic quality or timber in the note.

Doppler Effect

The apparent change in the frequency of sound due to relative motion between the source and the observer. The pitch (frequency) of the sound emitted by a moving object appears to a stationary observer to increse as the object approaches him and to decrease as it receeds from him.

Source in motion and listener at rest

The apparent pitch of thc sound heard by the listener,

$n=[V/(V\text{-}b)]\times n$ If the source is moving towards the listner at velocity b

If the source is moving away from the listner then.

$n'=[V/(V+b)]\times n$

Source at rest and listener in motion with velocity c

The apparent pitch of the sound heard by the listener

$n'=(V\text{-}c)\times n/V$ when listener is moving away from the source

If the listener is moving towards the source then

$n'=(V+c)\times n/V$

Source and listener both in motion

Source and listener both moving in the same direction in which the sound is travelling, then apparent pitch

$n'=(V\text{-}c)\times n/(V\text{-}b)$

Vibration in air Columns

When a vibrating body is held near the mouth of a pipe and when the frequency of the vibrating body coincides with one of the natural frequency of the column stationary longitudinal waves can be produced.

Closed organ pipe

For a closed pipe, the closed end is always a node and open end an antinode. The fundamental case corresponds to a length of the closed pipe $1=\lambda/4=V/4n$

Open organ pipe

Here both the ends are open and consequently they serve as antinodes. In the case of fundamental there is a single node in the middle and the length of the pipe $1=\lambda/2=V/2n$

Overtones

Notes of lesser intensity and higher pitch (i.e., of higher frequency) than the fundamental note, and superimposed upon the latter to give a note of characteristic quality.

Overtones in open pipe

The fundamental corresponds to two antinodes. The next possible mode corresponds to 3 antinodes so the length of the pipe

$$1=\lambda=V/n=2V/2n \text{ or } N_1=2n$$

The next overtone corresponds to

$$1=3\lambda/2=3V/2n \text{ or } N_2=3n$$

Thus open pipe emits notes of frequencies n, 2n, 3n, 4n...... etc., and hence all the harmonics are present when air in an open pipe vibrates.

Overtones in closed pipe

The fundamental corresponds to one node and one antinode. Next possible mode corresponds to two nodes and two antinodes, so the length of the pipe.

$$1=3\lambda/4=3V/4n \text{ thus } N_1=3n$$
$$\text{similarly } N_2=5n$$

Thus closed pipe emits notes of frequencies n, 3n, 5n, 7n,... ...etc., and hence only odd harmonics are present when air in a closed pipe vibrates.

Tuning fork

A two pronged metal fork which when struck, produces a pure tone of constant specified pitch. The frequency of the fork varies directly as the thickness of the prong and inversely as the square of the length of the prongs.

$$N=(m^2k/2\pi 1^2)\times\sqrt{Y/\rho} \text{ where } k=\text{thickness}/\sqrt{12}$$

1 is the length of the prong, Y is the young's modulus, ρ the density of the material of the fork and m is a constant. Nickel-Steel (an alloy) has much smaller temperature co-efficient and so tuning fork made of this alloy are commonly used.

Ultrasonics

The sound waves in which the frequencies are above the limits of human audibility i.e., frequencies above 20,000 cycles per second, are referred to as ultrasonics or supersonics. Applications of ultrasonics are

(a) Velocity in gases and liquids
(b) Acoustic grating
(c) Investigation of some aspect of structure of matter
(d) Elastic symmetries of crystals
(e) Sound signalling
(f) Depth sounding
(g) Detection of aircraft, submerged submarines and flaws in metals
(h) Medical and biological effect

Reverberration Time

Sabine's definition of the reverberration time T of an enclosure is the time in seconds required to reduce the sound intensity by 60 dB of its original intensity after it was stopped Sabine's equation for the determination of reverberration time is given by

$T = 0.049\ V/a$ where V = volume and a = total absorption

Period of reverberration is given by

$T = 0.05\ A/\Sigma\ a_1, s_1$ where $a_1 s_1$ is the absorbing power of the room

Absorbing co-efficient of a material is defined as the ratio of the absorption of sound energy by the surface to that of an equal area of a perfect absorber such as an open window.

A good acoustically designed room will have a few open windows, walls covered with absorbent materials, no curved walls or corners bounded by two walls, concave surfaces such as dooms, proper seating plan so as to secure good distribution of sound. Reverberration time should not be decreased beyond a certain optimum value. The desirable period of reverberration in seconds for halls with full audience is given by the emperical formula $T = 0.75 + 0.0175\sqrt{V}$ where V is the volume of the hall in cu-ft.

Magnetic Tape Recording and Reproduction

Sound from the microphone are amplified and fed to the coil of an electromagnet. A magnetic tape, which consists of a base of cellulose acetate and coated with finely divided ferric oxide on one side of the tape, is allowed to run past the poles of the electromagnet. The varying magnetic flux magnetises the tape in the same sequence and intensity as the sound to be recorded. The tape retains its magnetic field distribution indefinitely due to the magnetic properties of remanence and coercivity. For reproduction the tape is run past the poles of another electromagnet. The magnetised tape would set up varying magnetic strength in the electromagnet and this in turn would set changing electric field in the electromagnet coil which is amplified to produce back the sound recorded in the tape.

For erasing the tape is passed in front of an electromagnet called the eraser head. The head is energised by a current of 100Kc/s to wipe off any magnetisation of the tape.

LIGHT

Light

The agency by means of which a viewed object influences the observers eye. Consists of electromagnetic radiation within the wave-length range 4×10^{-7} metres to 7.7×10^{-7} metres approximately; variations in the wave-length produce different sensations in the eye, corresponding to different colours.

Mirrors, Spherical

Mirrors the reflecting surfaces of which form a portion of a sphere. The surface of such a mirror may be regarded as being made up of an infinite number of very small plane mirrors, each at a tangent to the curve of the mirror. Thus a ray of incident light would be reflected at any point as if from such a small plane mirror. If reflection takes place at the hollow side of the sphere, it is called a concave mirror and if reflection takes place at the outer or the bulging side, it is called a convex mirror.

Plane Mirror

If a luminous object is placed between two plane mirrors inclined to each other, a number of images of the object are formed. This number depends upon the angle between the two mirrors θ, the total number of images formed is given by

$$n=(2\pi/\theta)-1,$$

When the angle between the mirror is an exact multiple of π, and

$$n=2\pi/\theta, \text{ if } \theta \text{ is an odd multiple of } \pi$$

Lens

Any device which causes a beam of rays to converge or diverge on passing through it is a lens. The optical lens is a portion of a transparent reflecting medium, usually glass, bounded by two surfaces, generally curved. Such lenses are classified according to the nature of the surfaces into bi-concave, bi-convex, plano-convex etc.

Focal Lenghth of Concave and Convex Mirrors (Formula)

$$\frac{1}{U}+\frac{1}{V}=\frac{1}{F}$$

(a) light is assumed to come from the left.

(b) When the object is to the left of the mirror the distance of the object from the mirror is taken positive.

(c) When the image is to the left of the mirror the distance of the image from the mirror is taken positive.

(b) Focal length is positive for concave mirror and is negative for a convex mirror.

Reflection at a Single Spherical Surface

$$\frac{\mu_2}{V}-\frac{\mu_1}{U}=\frac{\mu_2-\mu_1}{R}$$

Where U and V are the distance of the object and the image from the centre of the reflecting surface having a radius of curvature R. The ray of light from a media having refractive index μ_1 is getting refracted by a single spherical surface which has a refractive index μ_2 ($\mu_1 \geqslant n_1$). The formula is valid only for small angles. $\frac{\mu_2-\mu_1}{R}$ is known as the power of the refracting surfaces and Lateral magnification is given by the relation.

$$\frac{\mu_1}{\mu_2}=\frac{V}{U}$$

Refraction Through a Thin Lens

$$\frac{1}{f}=(\mu-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)=\frac{1}{V}-\frac{1}{U}$$

The relation expresses focal length of thin lens of refractive index μ and radius of curvature of the surfaces R_1 and R_2. The formula is known as the lens makers formula.

Power of a Lens

Power of a lens in Diopter is given by

$P=1/f$ in metres$=(\mu-1)\times(1/R_1-1/R_2)$

P is positive for a convex lens and is negative for a concave lens.

Laws of Refraction of Light

When a ray of light travel from one medium to another, having different refractive indices, the ray of light suffers deviation.

(a) The incident ray, the refracted ray and the normal to the surface of separation of the two media at the point of incidence lie in the same plane.

(b) **Snell's Law.** The ratio of the sine of angle of incidence to the sine of angle of refraction is a constant for any pair of medium. The constant is termed as Refractive index of media 2 with respect to media 1.

$$\frac{\text{Sin i}}{\text{Sin r}}={}^1\mu_2=\frac{\text{velocity of light in medium 1}}{\text{velocity of light in medium 2}}$$

Total Internal Reflection

When light passes from a denser medium to a rarer medium the ray is bent away from normal. If the incident ray meets the surface at such an angle that the refracted ray must be bent away at an angle of more than 90°, the light cannot emerge at all, and is totally internally reflected. This angle of incidence is called *Critical Angle.*

Combination of Two Lenses

When two thin lenses of focal length f_1 and f_2 are placed at a distance 'd' apart. Their equivalent focal length F is given by the relation

$$(1/F)=(1/f_1)+(1/f_2)-(d/f_1f_2)$$

Defects of Images

The common defects observed in images produced by refraction at the curved surfaces or lenses are

(a) *Spherical Aberration.* The distortion of the image produced by a lens or mirror due to different rays from any one point of the object making different angles with the line joining that point to the optical centre of the lens or the mirror and coming to focus in slightly different position.

(b) *Chromatic Aberration.* The formation, by a lens, of an image with coloured fringes due to refractive index of glass being different for light of different colours. This light is thus dispersed into a coloured band. The effect is corrected by the use of achromatic lenses

(c) *Coma.* An error of a lens or spherical mirror which causes a blurred comet-like image

(d) *Curvature and Distortion.* Due to large aperture of mirrors the image obtained are usually curved and distorted. This defect is usually eliminated by allowing only a narrow pencil of rays to fall centrally on the mirror using stops at proper position.

(e) *Astigmatism.* A defect of lenses (including the eye) caused by the curvature being different in two mutually perpendicular planes, thus rays in one plane may be in focus while in the other plane may be out of focus, producing distortion. Astigmatism of the eye is corrected by the use of cylindrical lenses.

Dispersion

The splitting of light of mixed wave-lengths into a spectrum. A beam of ordinary white light, on passing through an optical prism or a diffraction grating, is divided up or dispersed into light of different wave-lengths of which it is composed; if the beam which emerges after disoersion is allowed to fall upon a screen, a coloured band or spectrum is observed.

Dispersive Power of a Medium

A measure of dispersion of light produced by a prism or a particular medium with respect to light of two specific wave-length ('a' and 'b'); given by the ratio $\frac{n_a - n_b}{n-1}$, where n_a is the refractive index of the medium of wave-length a' n_b that for wave-length b, and n is the average of n_a and n_b. When considering the dispersive power of media for ordinary white light, the dispersive power is often defined as $(n_b - n_r)/(n_y - 1)$ where n_b, n_r and n_y are the refractive indices for blue, red and yellow light respectively.

Dispersion, Angular

This is the difference in deviation between any two colours or mathematically

$$\delta_b - \delta_r = (n_b - n_r)\,\alpha$$

Where δ_r & δ_b = angle of deviation produced for blue and red coloured light respectively

n_b & n_r = the refractive indices for blue and red rays of light

α = angle of prism

The deviation for mean yellow light is

$\delta = (n-1)\alpha$ where n is the mean refractive index for the mean yellow light. For producing deviation without dispersion by using defferent prisms we have to satisfy the following condition

$$\omega\delta+\omega_1\delta_1=0$$

where ω and ω_1 are the dispersive powers of the materials of the two prism and δ and δ_1 are the deviation for yellow light.

Achromatic Prism

Achromatic prism is a combination of two prisms such that a ray of white light after passing through it may suffer deviation without dispersion. Two narrow angled prisms of different dispersive powers may be combined to produce dispersion without deviation. A direct vision spectroscope, used for quick examination of various part of spectrum, is an application of combination of small angled prisms of crown glass and flint glass to produce dispersion without deviation.

The condition that must be satisfied in order that a combination of two lenses of focal length f_1 and f_2 at a distance d cms apart be achromatic is

$$d=(f_1+f_2)/2$$

This combinational lens completely eliminates chromatic aberration for all colours.

Huygen's Wave Theory

According to this theory each point of wave front may be regarded as a new source of secondary wavelets. Knowing the position of the wave front at any given time, the construction enables its position to be determined at any subsequent time. Huygen supposed that the waves were longitudinal but it was later explained by Fresnel and Young that these waves were transverse in nature. The velocity V of a wave through an elastic medium of elasticity E and density ρ is given by $V=\sqrt{E/\rho}$

Corpuscular Theory

The theory that light consists of minute corpuscles in rapid motion is the Corpuscular theory. The sense of the different colours of light was supposed to be due to the corpuscles of different sizes striking the eye. Reflection and refraction phenomenon could be explained with this theory but interference, diffraction, polarisation etc., could not be explained.

Electromagnetic Theory

Clark Maxwell introducing this theory suggested that the light waves are composed of varying coupled electric and magnetic fields perpendicular to one another and to the direction of propagation of the wave. The velocity of propagation electromagnetic wave is given by $1/\sqrt{\mu\varepsilon}$ where μ is the permeability of the medium and ε is the dielectric constant. This theory is sucessful in explaining most of the phenomena in optics.

Quantum Theory

This theory which grew up around Planck's introduction of the concept of discontinuity of energy. EM theory suggests that emission or absorption by a body is continuous but according to quantum theory of radiation this is in discrete bundles or units. Energy associated with a quantum is proportional to the frequency ν of radiation and is given by $E = h\nu$ where h is called the Plank's constant.

Interference of Wave Motions

The addition of waves; if the crest of one wave meets the trough of another of equal amplitude, the wave is distroyed at that point, conversely, the superposition of one crest upon another leads to an increased effect. The colour effects of thin films are due to interference of light waves; beats produced by two notes of similar frequency are the result of interference of sound waves.

The resultant displacements at any point due to superposition of any system of waves is equal to the sum of the displacements of the individual waves at that point (Huygen's principle of superposition). This principle forms the basis of the theory of light interference.

Fresnel's Biprism

Fresnel's biprism is used for obtaining interference fringes; consists of two acute angled prisms placed base to base. The acute angle is of the order of 30′ or one degree. If 'd' is the distance between two virtual coherent source formed due to light from the source, placed at a distance 'x' from the biprism, getting refracted by the biprism and 'D' the distance between the source and the screen then β the fringe width is then given by $\beta = (D/d) \times \lambda$

Colour Vision

White light consists of a mixture of electromagnetic radiations of various wave-lengths. A surface which reflects all of these will appear white; some surfaces absorb some of the radiations they receive, and reflecting the rest. The one that is only reflected gives the sensation of that colour. In the case of colour seen by transmitted light, as in the case of coloured glass, the glass absorbs all the radiations except those which are visible, and which pass through.

Newton's Rings

Coloured rings which may be observed round the point of contact of a convex lens and a plane reflecting surface. Rings are formed due to interference between light waves reflected at the upper and lower surfaces of the air film separating the lens and the flat surface. The centre of the system of rings will be dark, provided the surfaces are in contact. If a small quantity of oil of SASSAFRAS, of which the refracting index is intermediate between the refractive index of crown glass, and flint glass, be placed between the lens of crown glass and a plate of flint glass, the centre of the system of rings is bright. Diameter 'd_n' of the nth dark ring is given by $d_n^2=4n\lambda R$ (dark ring for air film) and $d_n^2=4n\lambda R/\mu$ (dark ring for a film of refractive index μ). The Radii of the successive dark rings are proportional to the square roots of the natural number. The radii of the successive bright rings are proportional to the square root of odd natural numbers. Newton's rings are also called fringes of equal thickness.

Application of Phenomenon of Interference

(a) To the test the hardness of steel in the tempering process, the blacksmith uses the colour in thin film

(b) Accurate determination of wave-length

(c) Testing of plane surfaces

(d) Measurement of small displacement

(e) Non-reflecting glass

(g) To find the refractive index of a liquid or a gas

Michelson's Interfrometer

Is an apparatus with which interference fringes both of equal thickness and of equal inclination can be produced with large path differences by reflection at an air film. Some of the important use of this instruments are

(a) Measurement of standard metre in terms of standard wave-length

(b) Determination of wave-length of monochromatic light. If n is the number of fringes that moves across the field of view when the mirror is displaced through a distance l, than $\lambda=2l/n$

(c) Determination of thickness of a transparent medium or refractive index

$(\mu-1)\times t=1$ where l is the distance through which the mirror is moved

(d) Difference between two wave-length or resolution of spectral lines

$$(21/\lambda_1)-(21/\lambda_2)=1$$

(e) Angular diameter of stars.

Diffraction

When a beam of light passes through an aperture or past the edge of an opaque obstacle and is allowed to fall upon a screen, patterns of bright and dark band (with monochromatic) or coloured band (with white light) are observed near the edges of the beam, and extended into the geometric shadow. This phenomenon which is a particular case of interference, is due to the wave nature of light, and is known as diffraction. The phenomenon is common to all wave motion.

Zone Plate

Zone plate acts both as a convergent and as a divergent lens with mutiple focii. Its construction is based on the fact that, since the areas of half-period zones are equal, their radii are in the ratio of $1:\sqrt{2}:\sqrt{3}:\sqrt{4}$ etc.

The division of a wave front into elements of area zone such that secondary wavelets reaching a given point ahead of the wave from the adjacent zones differ in phase by half a period, or π. This construction is used in theoritical investigation of fresnel diffraction in simple cases.

Fresnel's Diffraction

In this type of diffraction the light source or the receiving screen, or both, are at a finite distance from the diffracting system. Fresnel type of diffraction is produced when light suffers diffraction at a straight edge, a narrow slit, a thin wire, a small circular hole, or an obstacle.

Fraunhofer Diffraction

The class of diffraction phenomena in which both the light source and the receiving sereen are effectively at an infinite distance from the diffracting system.

Diffraction Grating

A device used to disperse a beam of light, X-ray, Or other EM radiation into its constituent wave-length. It may consists of any device which acts upon an incident wave front similar to that of a regular array of parallel slits where slit width is of the same order as the wave-length of the incident radiation. Such grating may be plane or concave and may be prepared by ruling equidistant parallel lines on to a glass (transmission grating) or metal surface (reflection grating). In diffraction grating the condition for principle maxima are.

$$(a+b)\ \mathrm{Sin}\theta = n\lambda$$

The grating spectrum is called a normal spectrum.

Resolving Power

The ability of an optical system to produce separate images of objects very close to together. The dispersive power of an instrument involves merely the angular separation of the lines (or wave-length) in the spectrum. The degree of closeness of the two lines corresponding to two near wave-length is a measure of the resolving power.

Resolving power of prism $= \dfrac{\lambda}{d\lambda} = -t\dfrac{d\mu}{d\lambda}$

Where t is the thickness of the base of the prism

Resolving power of a diffraction grating $= nM =$ order of the spectrum × total number of lines used on the grating

Resolving power of a telescope. The reciprocal of the minimum angular separation that the two points must have in order that their diffraction pattern will not overlap, gives the resolving power of the telescope. Mathematically is given by $d\theta = 1.22\lambda/d$

Rayleigh's Criterion

The two images of point objects lying close to each other are said to be separated if the central maximum of one falls on the first secondary minimum of the other. This is the criterion for resolution and is known as Rayleigh's limit or resolution.

Polarisation of Light

Electric (E) and magnetic (H) vibrations of an ordinary light vibrates in all possible planes containing the ray, the vibrations themselves being at right angles to the direction of the light path, i.e., light is transverse in nature. For each E vibrations the associated H vibrations takes place in a plane at right angles to it. In a plane polarised light the E vibrations are confined to one plane, called the plane of vibration, and hence the associate H vibrations are also confined to one plane, the plane at right angle to this called the plane of polarisation.

Brewster's Law

When the light is incident at the polarising angle the reflected and the refracted rays are perpendicular to each other. Thus the tangent of the angle of polarisation is numerically equal to the refractive index of the reflecting medium when the polarisation is maximum.

Malus Law

The intensity of the light emerging from the analyser, consisting of a pile of plates, is proportional to the square of the cosine of the angle between the polariser and the analyser.

Polaroid

It is the other name for thin transparent films which produce plane-polarised light on transmission. Consists of thin sheets of cellulose nitrate packed with ultramicroscopic doubly refracting crystal produce plane polarised light by differential absorption of the ordinary and extraordinary rays.

Double Refraction

When a ray of light is incident on a calcite or a quartz crystal, it is generally split up into two refracted rays. One of these obey ordinary laws of refraction and is called the ordinary ray; the other does not obey the ordinary laws of refraction and is called extraordinary ray. This phenomenon is known as double refraction. If light falls on the crystal along or, in the direction of the optical axis, the ordinary and the extraordinary rays have same velocity and direction and hence there is no double refraction along this direction.

Nicol's Prism

An optical device, constructed from a crystal of calcite, used for obtaining plane polarised light. When light is passed through a doubly refracting crystal it is split up into the O and E rays both of which being plane polarised. One of them is absorbed by total internal reflection

Elliptically Polarized Light

Light which can be resolved into two vibrations lying in planes at right angles, and of equal frequency. The electric vector at any point in the path of the wave describes an ellipse about the direction of propogation of the light.

Circularly Polarised Light

Light which can be resolved into two vibrations lying in planes at right angles, of equal amplitude and frequency and differing in phase by 90°. The electric vector E of the wave describes, at any point in the path of the wave, a circle about the direction of propogation of the light.

Quarter-Wave Plate

A plate of doubly refracting material cut parallel to the optical axis of the crystal, and of such a thickness that a phase difference of $\pi/2$ or 90° is introduced between the ordinary and extraordinary rays of light of a particular wave-length. Plane polarised light incident normally upon such a plate, with its plane of vibration making an angle of 45° with the optical axis, emerges from the plate circularly polarised.

Half Wave Plate

A plate of doubly refracting material cut parallel to the optical axis of the crystal, and of such a thickness that a phase difference of π or 180° is introduced between the ordinary and extraordinary rays of light for a particular wave-length. The half wave plate is chiefly used to alter the plane of vibration of plane-polarised light.

Faraday Effect

The rotation of the plane of polarisation by a substance under a magnetic field is called the Faraday effect.

Emission Spectra

The spectrum observed when light coming directly from a source is examined with spectroscope. An emission spectrum is of two kinds (a) *continuous* and (b) *Discontinuous*. Incandescent solids and liquids, when white hot, emit light of all wave-length and its minimum wave-length of emission depends upon the temperature of the body. Such spectra presents a continuous band of colours in a spectrometer. The solar spectrum is an example of continuous spectrum. Discontinuous spectra are of two types, *band spectra* and *line spectra*. In band spectra there are a large number of bright bands of light. The intensity of light is maximum in one edge and falls off at the other edge. Chemical compounds in the vapour state emitt band spectra when not heated too strongly. Study of band spectra provides useful information regarding the chemical condition of a source of light. Line spectrum is a spectrum (absorption or emission) consisting of definite single lines, each corresponding to a particular wavelength. The line spectrum of an element is due to the vibrations or excited conditions of the atoms of the element. These are emitted by vapourised substances in flames or in electric arc, and by gases in discharge tubes.

Absorption Spectra

A spectrum consisting of dark lines or bands, obtained when light from a source, giving out continuous range of wave-lengths is passed through a non-opaque matter (solid, liquid, vapour or a gas), into a spectroscope. The dark lines or bands will occur in the same position as the coloured lines in that substances emission spectrum and will be characteristic of the substance. An absorption spectrum could be continuous absorption spectrum or line absorption spectrum. When the absorbing medium is in the solid or liquid state the spectrum of the transmitted light shows broad dark regions which are not resolvable into sharp lines. Characteristic X-ray and ultraviolet absorption spectra are also formed.

Photoelectric Effect

The emission of the electrons by substances when irradiated with of a frequency greater than a certain minimum threshold frequency. Electrons liberated in this way are called photo-electrons and constitute a photo-electric current when connected to a suitable circuit.

Einstein's Photon Theory

This theory explains photo-electric effect. Einstein assumed that the energy in a light beam travels through space in concentrated bundles, called photons. The energy E of a single photon is given by $E = h\nu$. Einstein's hypothesis suggests that light travelling through space behaves not like a wave at all but like a particle. He expressed photo-electric effect in the following equation form

$$h\nu = E_0 + K\text{max}$$

A photon carrying an energy $h\nu$ expends a part of the energy E_0 in causing the electron to pass through the metal surface and the energy $(h\nu - E_0)$ is given to the electron in the from of kinetic energy.

Compton Effect

The incident photon carrying an energy $h\nu$ transfers some of its energy to the electron with which it collides, the scattered photon must have a lower energy E′, it must therefore have a lower frequency $\nu^1=(E'/h)$, which implies a larger wave-length λ^1. The reduction in the energy of a photon, as a result of its interaction with free electron is called Compton effect. Part of the photon's energy is transferred to the electrons (called compton or recoil electron) and part is redirected as a photon of reduced energy (compton scatter).

The Correspondence Principle

The fact that quantum physics reduces to classical physics at large quantum numbers is called the correspondance principle. This principle is credited to NIELSBOHR

Zeeman Effect

When a substance which emits a line spectrum is placed in a strong magnetic field, the single lines are split up into two groups of closely spaced lines. This phenomenon is called the Zeeman effect. From the separation of the lines in these groups information on atomic structure can be deduced.

Raman Effect

When a monochromatic light passes through a transparent medium, some of the light is scattered. If the spectrum of this scattered light is examined, it is found to contain apart from light of original wavelength, weaker lines differing from this by a constant amount. Such lines are called the Raman lines, and they are due to loss or gain of energy experienced by the photons of light as a result of interaction with the vibrating molecules of the medium through which they pass. The Raman effect is therefore useful in the study of molecular energy levels.

Fluorescence and Phosphorescence

Those which emit radiation only during the action of stimulating light is called *fluorescent*. Those which continue to emit radiations for some time after the exciting light is removed, are called *phosphorescence*. Quinine sulphate, fluorspar are some of the examples of fluorescent substance, while calcium oxide is an example of phosphorescene. Fluorescence occurs when the atoms of the fluorescent substance absorb a portion of the incident radiation of shorter wave-length and remits it in the form of radiations of longer wave-length (Stroke's law) with some exceptions. In phosphorescent substance some kind of chemical changes is produced by the original illumination. This change is unstable and therefore the phenomena is only temporary. The magnetic and dielectric properties of phosphorescent substances are different before and after illumination.

ELECTRICITY AND MAGNETISM

Electricity

A general term used for all phenomena caused by the electric charge whether static or in motion.

Electric Line of Force

A line in an electric field whose direction is everywhere that of the field.

Electric Potential at a point

The work necessary to bring unit positive electric charge from an infinite distance to that point.

Electric Field

The region near an electric charge, in which a force is exerted on a charged particle; completely defined in magnitude and direction at any point by the force upon unit positive charge situated at that point. The field strength E, or force exerted upon a unit charge at a distance r from a charge Q is given by

$$E = Q/4\pi r^2 \varepsilon$$

where ε is a permitivity.

Electric intensity

The strength of an electric field at a point.

Eiectric Current

An electric current is said to flow through a conductor when there is an overall movement of electrons through it. The SI unit of current is the ampere. Symbol I.

Electric Displacement

Consider a uniform electric field of strength E in free space; i.e., the electric flux through unit area perpendicular to the field is E. Now suppose a dielectric medium is introduced into the field. The electric flux at any point in the medium becomes modified owing to the interaction between E and the atoms of the dielectric, and assumes a new value D, called the electric displacement.

Electric Polarisation

When an electric field is applied to an electrically neutral atom, a displacement of the electrons with respect to the positive nucleus occurs. This gives rise to a small electric dipole possessing an electric moment in the direction of the field. This effect occurs when a dielectric is placed in an electric field, the electric field acting upon each individual atom of the dielectric. The resultant total electric moment per unit volume is called as electric polarisation.

Magnetic Field

A field of force which is said to exist at any point if a small coil of wire carrying an electric current experiences a couple when placed at that point. A magnetic field may exist at a point as a result of the presence of either a permanent magnet or a circuit carrying an electric current, in the neighbourhood of the point.

Magnetic Field of Electric Current

A wire or coil carrying an electric current is surrounded by a magnetic field. The direction of the field relative to the current may be determined by the corkscrew rule.

Magnetic Field Strength

The strength of a magnetic field measured in amperes per metre.

Magnetic Flux

The product of a given area and the component of the magnetic field strength at right angles to that area.

Magnetic Line of Force

A line whose direction at each point is that of the magnetic field at that point; the path along which a free magnetic pole would travel.

Magnetic Moment

The couple required to hold a magnet at right to the field of unit magnetic intensity; the product of the magnetic pole strength and the length of the magnet.

Magnetic Permeability

The ratio of the magnetic flux density in a body to the external field strength which induces it. The relative permeability μ_r, is the ratio of the permeability of the substance to the permeability of the vacuum, μ_0, μ_0 has the value $4\pi \times 10^{-7}$ henry per metre. For most substances μ_r constant has a small value. When μ_r is less than one, the material is said to be diamagnetic, if greater than one, it is paramagnetic. A few substances, notably iron, have very large values of μ, which tend to fall as the field strength increases so that the magnetic flux density tends to a limiting value called the saturation value. Such substances are said to be ferromagnetic.

Magnetic Pole

A magnet appears to have its magnetism concentrated at two points termed the poles. If a bar magnet is suspended to swing freely, one of these, the north seeking. North or positive pole, will point north, and the other south. Unlike poles attract, and the like poles repel each other. The force of attraction or repulsion between two poles varies inversely as the square of the distance between them.

Magnetic Potential

Concept analogous to electric potential; the difference of magnetic potential between two points is measured by the work done in carrying a unit magnetic pole from one point to the other.

Magnetic Susceptability

The ratio of the intensity of magnetisation produced in a substance to the strength of the magnetic field to which it is subjected.

Magnetostriction

A change in the dimensions of the ferromagnetic substances on magnetisation.

Inductance

The property of an electric circuit as a result of which an electromotive force is generated by a change in the current flowing through the circuit, or by a change of current in a neighbouring circuit with which it is magnetically linked. Its unit is henry.

Capacitance

The property of a system of electrical conductors and insulators which enables it to store electric charge when a potential difference exists between the conductors. Measured by the charge which must be communicated to such a system to raise its potential by one unit.

ATOMIC PHYSICS

Atom

The smallest portion of an element which can take part in a chemical reaction.

Structure of Atom

The atom consists of a positively charged central core, the nucleus surrounded by one or more negatively charged particles, electrons.

Atomic Mass

The mass of an isotope of an element measured in atomic mass units.

Atomic Number

The number of electrons rotating round the nucleus of the neutral atom of an element, or the number of protons in the nucleus.

Nucleus

The positively charged core of an atom, consisting of one or more protons and, except in the case of hydrogen, one or more neutrons. The number of protons in the nucleus is given by the atomic number and the number of neutrons by the difference in the mass number and the atomic number. Nearly the whole of the mass of the atom is concentrated in the nucleus, which occupies only a tiny fraction of its volume.

Nuclear transmutations:

The changing of atoms of one element into those of another by suitable nuclear reactions.

Nuclear Fission

A nuclear reaction in which a heavy atomic nucleus splits into approx, two equal parts, at the same time emitting neutrons and releasing very large amounts of nuclear energy.

Nuclear Fusion

A nuclear reaction between light atomic nuclei as a result of which a heavy nucleus is formed and a large quantity of nuclear energy is released.

Nuclear Energy

Energy released during a nuclear reaction as the result of a conversion of mass into energy.

Radioactivity

The property of spontaneous disintegration possessed by certain types of unstable nuclei. The disintegration is accompanied by the emission of either an alpha, beta or a gamma particle rays.

USEFUL CONVERSION FACTORS

1 Light year = 9.46070×10^{15} metres = 5.87848×10^{12} miles
1 Astronomical unit = 1.495×10^{11} metres
1 parsec = 3.0857×10^{16} metres = 3,2616 light years
1 hectare = 10,000 sq-metres = 2.47105 acres
1 gallon (US) = 0.83268 gallon (UK)
1 knot = 1 nautical mile per hour 0.514444 metre per second
1 slug = 14.5939 kg = 32. 174 lbs
1 newton per sq-metre = 10 dynes per sq-centimetre
1 bar = 10^5 newtons per sq-metre = 0.986923 atmosphere
1 torr = 133.322 newtons per sq-metre = 1/760 atmosphere
1 atmosphere = 760 mm of mercury = 33.90 ft water (all at 0°C)
1 joule = 1 newton metre = 1watt second = 10^7 ergs = 0.737561 ft lb
1 electron volt = 1.60210×10^{-19} joule
1 Atomic mass unit = 1.66×10^{-27} Kg
1 angstron unit = 10^{-10} metres = 0.1m
1 Millimicron = 10^{-9} metre
1 mile/hr = 1.47 ft/sec = 0.447 metre/sec
1 Btu = 778 ft-lb = 252 cal = 1060 Joules
1 electron volt = 1.60×10^{-19} joules
1 horsepower = 550 ft-lb/sec = 746 watts
1 Weber/metre^2 = 1 tesla = 10^4 guass

USEFUL CONSTANTS IN SI UNITS

Constant	*Symbol*	*Si Units*
Electronic charge	e	1.60210×10^{-19} coulomb
Electronic rest mass	m_e	9.1091×10^{-31} kilogram
Electronic radius	r_e	2.81777×10^{-15} metre
Proton rest mass	m_p	1.67252×10^{-27} kilogram
Neutron rest mass	m_n	1.67482×10^{-27} kilogram
Plank's constant	h	6.62559×10^{-34} joule second
Velocity of light	c	2.997925×10^{8} metres per second
Avogadro's constant	L, N_A	6.02252×10^{23} per mole
Gas constant	R	$8.3143\ J\ K^{-1}\ mol^{-1}$
Boltzmann's constant	$k = R/N_A$	$1.38054 \times 10^{-23}\ J\ K^{-1}$
Faraday's constant	F	$9.64870 \times 10^{4}\ C\ mol^{-1}$
Stefan-Boltzmann constant	σ	$5.6697 \times 10^{8}\ W\ m^{-2}\ K^{4}$
Gravitational constant	G	$6.670 \times 10^{-11}\ N\ m^{2}\ Kg^{-2}$
Acceleration due to gravity	g	$9.80665\ ms^{-2}$
Permeability of vacuum	μ_0	$4 \times 10^{-7}\ H\ m^{-1}$
Permittivity of vacuum	ϵ_0	$8.85418 \times 10^{-12}\ Fm^{-1}$
Escape velocity of earth	—	$11\ Km\ s^{-1}$
Standard atmospheric pressure	—	$1.013 \times 10^{5}\ Nm^{-2}$
Density of dry air at NTP	—	$1.293\ Kg\ m^{-3}$
Speed of sound in dry air at NTP	—	$331.46\ m\ s^{-1}$
Mass-Energy Relation	$C^2 = (E/m)$	931 Mev/amu $= 8.99 \times 10^{16}$ Joles/sec
Triple point of water	T_{tr}	273.16^0K
Electron megnetic moment	—	9.27×10^{-24} Joule/tesla
Density of air (STP)	—	1.29 Kg/metre^3
Density of water (20° C)	—	1.00×10^{3} Kg metre^3
Density of mercury (20°C)	—	13.5×10^{3} Kg/metre^3
Standard Atmosphere	—	1.01×10^{5} nt/metre^2 $= 14.71b/in^2 = 760$ mm-Hg
Mean radius of the earth	—	6.37×10^{6} metres $= 3860$ miles

Mean sun-earth distance	—	1.49×10^8 Km=92.9×10^6 miles
Mean Earth-moon distance	—	3.80×10^5 Km=$2. 39 \times 10^5$ miles
Heat of fusion of water (0°C, 1 atm)		79.7 cal/gm
Heat of vapourisation of water (100°C, 1 atm)		539 cal/gm
Melting point of ice	—	273.15°K
Ratio of specific heats (r) for air (20°C)	—	1.40
Wave length of sodium yellow doublet		5892 A
Index of refraction of water (5892 A)		1.33
Index of refraction of crown glass (5892 A)		1.52

ANSWERS

1	b	2	a	3	c	4	d
5	c	6	b	7	b	8	a
9	d	10	a	11	d	12	d
13	b	14	d	15	a	16	b
17	b	18	a	19	b	20	b
21	d	22	a	23	d	24	c
25	b	26	a	27	a	28	c
29	c	30	b	31	a	32	a
33	a	34	b	35	c	36	d
37	c	38	b	39	d	40	a
41	b	42	d	43	b	44	a
45	a	46	b	47	b	48	b
49	d	50	b	51	a	52	d
53	b	54	b	55	c	56	b
57	d	58	b	59	d	60	d
61	a	62	d	63	c	64	a
65	b	66	c	67	b	68	a
69	c	70	a	71	b	72	a
73	d	74	d	75	c	76	b
77	a	78	a	79	b	80	c
81	c	82	a	83	c	84	a
85	c	86	b	87	a	88	b
89	c	90	b	91	b	92	b
93	a	94	b	95	a	96	b
97	d	98	c	99	a	100	b
101	c	102	c	103	a	104	c
105	a	106	c	107	c	108	c
109	b	110	d	111	b	112	b
113	b	114	b	115	a	116	b
117	c	118	c	119	d	120	c
121	c	122	a	123	b	124	d
125	a	126	c	127	b	128	c
129	a	130	c	131	d	132	d
133	c	134	a	135	b	136	c

137	c	138	c	139	b	140	b
141	d	142	a	143	c	144	c
145	b	146	c	147	a	148	b
149	a	150	d	151	d	152	b
153	a	154	b	155	b	156	c
157	b	158	b	159	c	160	d
161	b	162	b	163	d	164	c
165	a	166	d	167	c	168	c
169	d	170	b	171	c	172	a
173	b	174	b	175	c	176	a
177	c	178	a	179	d	180	b
181	c	182	c	183	b	184	a
185	c	186	a	187	b	188	d
189	d	190	b	191	b	192	b
193	b	194	a	195	b	196	c
197	d	198	d	199	c	200	a
201	b	202	b	203	b	204	c
205	a	206	b	207	c	208	d
209	a	210	c	211	b	212	a
213	b	214	d	215	d	216	c
217	c	218	a	219	c	220	a
221	c	222	d	223	d	224	c
225	b	226	c	227	d	228	a
229	b	230	b	231	d	232	a
233	a	234	c	235	b	236	c
237	c	238	c	239	d	240	c
241	d	242	b	243	a	244	b
245	d	246	d	247	d	248	a
249	d	250	c	251	c	252	a
253	b	254	c	255	d	256	b
257	c	258	a	259	a	260	c
261	c	262	b	263	d	264	b
265	d	266	c	267	a	268	d
269	b	270	b	271	a	272	c
273	a	274	d	275	c	276	a
277	c	278	b	279	a	280	d
281	c	282	b	283	a	284	a
285	a	286	c	287	b	288	d
289	d	290	c	291	b	292	c

293	c	294	c	295	c	296	b
297	d	298	a	299	c	300	a
301	d	302	d	303	c	304	c
305	a	306	a	307	b	308	b
309	c	310	b	311	a	312	c
313	d	314	d	315	c	316	a
317	c	318	b	319	c	320	b
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329	b	330	b	331	c	332	a
333	a	334	c	335	b	336	d
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341	b	342	b	343	b	344	a
345	d	346	d	347	a	348	c
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353	c	354	b	355	b	356	c
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453	c	454	c	455	b	456	b
457	a	458	c	459	a	460	c
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465	b	466	d	467	a	468	d
469	d	470	d	471	b	472	c
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601	b	602	b	603	d	604	b

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717	c	718	b	719	b	720	c
721	d	722	a	723	d	724	b
725	c	726	a	727	b	728	c
729	b	730	c	731	d	732	a
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749	b	750	d	751	a	752	b
753	c	754	d	755	d	756	c
757	a	758	b	759	a	760	c

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765	b	766	b	767	c	768	b
769	a	770	c	771	c	772	b
773	d	774	b	775	b	776	a
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813	d	814	d	815	d	816	c
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873	d	874	d	875	b	876	d
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881	c	882	c	883	b	884	b
885	d	886	a	887	b	888	b
889	d	890	b	891	c	892	b
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913	d	914	b	915	c	916	c

917	c	918	c	919	c	209	c
921	c	922	d	923	d	924	b
925	c	926	b	927	a	928	a
929	b	930	b	931	b	932	c
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965	d	966	c	967	c	968	d
969	d	970	d	971	c	972	d
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985	c	986	b	987	b	988	a
989	b	990	a	991	c	992	a
993	b	994	c	995	b	996	a
997	c	998	b	999	b	1000	b
1001	b	1002	d	1003	d	1004	a
1005	b	1006	c	1007	d	1008	c
1009	d	1010	b	1011	b	1012	b
1013	b	1014	c	1015	c		

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